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ANNUAL RECORD

OF

SCIENCE AND INDUSTRY

FOR 1875.

EDITED BY

SPENCER F. BAIRD,

WITH THE ASSISTANCE OF EMINENT MEN OF SCIENCE.

NEW YORK:
HARPER & BROTHERS, PUBLISHERS,
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1876.

PREFACE.

In presenting to the public the fifth volume of the series of the "Annual Record of Science and Industry," a few words in explanation appear to be called for.

In each of the successive numbers already published, new features have been introduced, suggested by experience as well as by the advice of the scientific collaborators and friends of the editor.* These are exemplified in part by the increasing number of communications and criticisms on progress in the various branches of science, and by the greater extent of historical résumés given under the caption of "General Summary of Progress." These have gradually increased in the successive years from 16 pages in the volume for 1871, to 272 in that herewith presented.

The editor has been pleased to notice that his endeavors thus to increase the value of the work have been on the whole cordially appreciated by the public at large. With much of praise, however, sundry friendly suggestions for modifications and improvements have been made which merit attention. It has been urged, on the one hand, that some new facts and memoirs deserving of attention have not been referred to; on the other, that the preliminary

* Among those who have taken part in the preparation of the historical Summaries, or of abstracts of articles belonging to their respective specialties, or who have supplied early reports of their own original researches, may be mentioned: Professors Simon Newcomb, Cleveland Abbe, Edward S. Holden, Theodore Gill, and O. T. Mason, of Washington; Professors G. F. Barker, E. D. Cope, and Dr. William Wahl, of Philadelphia; Professor C. F. Himes, of Carlisle, Pa.; Dr. Charles Rau, of New York; Dr. E. S. Dana, of New Haven; Professor W. O. Atwater, of Middletown, Conn.; Dr. T. Sterry Hunt, of Boston; Dr. A. S. Packard, Jr., of Salem; Professor Asa Gray and Dr. W. G. Farlow, of Cambridge; Professor Hamilton L. Smith, of Geneva, N. Y.; Professor F. W. Clarke, of Cincinnati; Prof. A. W. Bennett, of London, and other gentlemen who prefer to remain unnamed.

Summaries of Progress would be sufficient alone, without any paragraphs recording individual discoveries. It would, of course, be impossible to satisfy such discrepant opinions, and in this dilemma the only resource left to the editor has been to follow a mean which he hopes will be regarded by most as a tolerably happy one. It must be remembered that far more than ten times the space contained in the present volume would be necessary to give even an approximately complete abstract of the progress of science in each of the departments embraced within the scope of this work: much more than that amount will in fact be employed in the annual reports that are hereafter to be made and published on the progress of the several departments of science for the past year. These reports, for 1875, however—unlike the present volume—will not appear till at least one, and, in some cases, two or three or even four years have elapsed. These too are, to a certain extent, addressed rather to experts and special students in the various branches of science than to the general reader, for whom the "Annual Record" is more especially designed. In them the several branches embraced herein are respectively reported upon, in volumes varying from little less than five hundred pages to nearly two thousand each year. Each special department of science has now its own organ for the record of discoveries within its domain. All these are extremely useful to the investigator, and enable him to economize precious time, that would otherwise be spent in frequent reference to numerous volumes, some of which are almost or quite inaccessible to all save a favored few. Several, also, are very elaborate, and the special subdivisions within a single branch are reported upon by experts in the respective subdivisions. Excellent examples of such reports are found in the *Jahresberichte* and *Jahrbücher*, published in Germany, on the mathematical, physical, and chemical sciences. Some branches have even two or more annual works devoted to the record of progress in their several spheres; such are especially Zoology, on which one report is published in Germany and another in England; Botany,

which has one in Holland and another in Germany; while for Anatomy there are two in Germany alone. To reports like these (for the most part enumerated in the volume for 1874) must the student refer who desires to obtain information respecting the more technical or special facts or generalizations that have been announced. The present volume can administer to their needs only to a limited extent. But the editor hopes that by the relations which he has established with a number of the most eminent cultivators of the different departments of science in this country, and through their co-operation, he has been enabled to present as complete and reliable a résumé of discovery as can reasonably be expected within the limited space to which an annual like the present must be restricted.

As now presented, the *Record* has two distinct parts: (1) the historical summaries of progress during the past year, and (2) the paragraphs communicating in brief the results of investigations by special scientists, or respecting certain subjects. The advantages of the paragraph method, so generally in vogue in analogous publications in the English and other languages, are combined with the more consecutive and eliminating characteristics of the historical; the latter is a much more prominent feature in the present volume than in any of its predecessors, and special attention will be devoted to it in the future.

A list of some of the more prominent publications on scientific subjects which have appeared during the past year has been prepared for this volume. In the selections for this list we have been chiefly guided by the commendatory notices which have appeared in the more prominent scientific journals of the day, and references to the pages of the journals wherein the works catalogued are reviewed are given. As the journals in question are generally easily accessible, the reader is thus furnished with a trustworthy guide in his selection of books.

SPENCER F. BAIRD.

SMITHSONIAN INSTITUTION, WASHINGTON, *March* 28, 1876.

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* In the arrangement of articles in the body of the *Record*, it was found impracticable to place them in proper systematic sequence, especially as many belonged as much to one division as to another, sometimes even to three or four equally. The present systematic Table is intended to remedy the difficulty, by bringing together in proper order all the titles of articles, and, by a system of cross references and duplications, to point out all matter relating to any one subject, whatever be its situation in the volume. The references in Roman letters preceding the page references of the headings relate to the pages of the introductory "Summary."

GENERAL SUMMARY

OF

SCIENTIFIC AND INDUSTRIAL PROGRESS DURING THE YEAR 1875.

MATHEMATICS AND THEORETICAL MECHANICS.

On account of the importance of the cultivation of pure Mathematics among American scientists, we note first that the editor of *The Analyst*, Professor J. E. Hendricks, of Des Moines, Iowa, states that a number of his subscribers have concluded to discontinue their subscriptions, since the subjects discussed in that mathematical journal are too difficult, and some of his friends advise him to make the contents of *The Analyst* somewhat more elementary, and to give small premiums to clubs, prizes, etc. He states, however, that the publication was inaugurated, not with the hope of being able to make it popular at present, but for the purpose of affording a medium for the interchange of thought by students and teachers of mathematics. Hence he does not anticipate that any person will subscribe who will not derive from it knowledge to the extent of its cost; and that *The Analyst* will continue to be a medium for interchange of thought, but will not become to any great extent purely an educational journal. The great good that will result to the progress of mathematical studies in this country by the presence among us of a good mathematical journal is sufficient to justify Mr. Hendricks in his self-imposed labors and expensive undertaking.

American mathematicians have contributed two valuable papers to the theory of the movements of systems of planets, etc. Of these, the first, by Newcomb, on the "General Integrals of Planetary Motion," was published by the Smithsonian Institution; the second, by Hill, on the "Development of the Perturbative Function," is to be found in *The Analyst*.

The theoretical researches of Le Verrier into the movements

and general perturbations of the eight principal planets having at length been brought to a conclusion, he has presented an account of them to the French Academy of Sciences, and announces that his tables of Saturn, Uranus, and Neptune are rapidly approaching completion.

The somewhat startling announcement recently made by Mr. Stockwell, of Ohio, that he had discovered important errors in the mathematical portions of the accepted lunar theories, and which he has undertaken to correct, has, we believe, been negatived by the reply of Schjellerup, of Copenhagen, according to whom the error is apparently on Mr. Stockwell's own side.

Veltmann applies to the general law of movements of three or more bodies the calculus of determinants, and in this way arrives at some interesting formulæ.

ASTRONOMY.

Observers, Observatories, and Instruments.—The publication of the excellent series of astronomical engravings has been concluded by the Observatory at Harvard College. The text is also prepared, and will probably be published immediately on the appointment of Professor Winlock's successor.

The observatory erected on the grounds of Columbia College, in New York, has been connected with the systems of telegraph lines throughout the city, and will, it is hoped, soon be in a position to systematically furnish standard time to that city.

The great Cassegrainian reflector, of 26 inches' aperture, constructed by Dr. Henry Draper, has been properly mounted in a dome, with every convenience for use, at his father's country-seat at Hastings-on-the-Hudson; but its great powers have not, as yet, on account of bad weather, been fully demonstrated. For the sake of astronomy in America, it is to be hoped that he may be able to wrest from many business cares some time for the prosecution of astronomical physics.

In connection with the observations of the transit of Venus, it should be mentioned that the American parties owe a great deal of their success in photographic matters to the friendly counsel of Dr. Draper, who very generously devoted two months' time to the proper outfit of the parties in

this respect, and who has received in return, from the Transit of Venus Commission, a beautiful gold medal, as an acknowledgment of his gratuitous services.

The observatory erected several years ago by Professor Mayer in connection with Lehigh University, and now for some time unused, has been placed in charge of Mr. C. L. Doolittle.

The directorship of the observatory at Cincinnati, which has been vacant since 1872, has recently been filled by the election of Mr. Ormond Stone.

The hopes expressed in the *Annual* for 1874, as to the speedy realization of the great project of Mr. James Lick, of California, have been somewhat dampened by the occurrence of a legal controversy—which seems an inevitable attendant of every great bequest for the advancement of learning. The original trustees having returned into Mr. Lick's hands the trust confided to them, he appears now, from what we can gather, to have personally interested himself in the execution of his own plan; and it is announced that he has made a formal offer to the trustees of Santa Clara County, in which he proposes to erect his observatory, on the summit of Mount Hamilton, provided the proper authorities will be at the expense of a well-graded carriage-road from the base to the summit.

The rage for large objectives continues as active as ever. It is said that the glass for making one of 30 inches in diameter is now held by Yale College.

The report of the National Observatory of the Argentine Confederation for the year ending November, 1874, has been received, and it appears therefrom that Dr. Gould, the director, has labored with an energy rarely equaled for the consummation of the great works undertaken by him.

For the new observatory at Quito, under the superintendence of Father Menten, a fine telescope has been constructed by Merz. It has a clear aperture of 9 Paris inches, and a focal length of 117 inches.

It is stated that Professor Gonzalez, director of the National Observatory at Bogota, has resigned his position in order to establish a new and private observatory, at an altitude of nine thousand feet, in latitude 4½° north.

The new observatory at Oxford has received as its direc-

tor the Rev. C. Pritchard, Savilian professor of astronomy at the university.

The observatory at Twickenham, belonging to Mr. Bishop, and for a long time occupied by Mr. Hind, as observer, is shortly to be dismantled, and its instruments presented to the Royal Observatory at Naples.

The astronomical school established at Montsouris, under the authority of the French Bureau of Longitudes, was opened on the 3d of October with six pupils. The period of study is six months.

The new meridian room, intended for the use of the French Bureau of Longitudes, was opened on the 2d of October.

A magnificent astronomical establishment is being erected at Potsdam for the express purpose of studying the sun.

The French government has taken steps toward the establishment of a physical observatory in the neighborhood of Paris, under the direction of Janssen. The building will probably be located either at Versailles or Montelhuy.

Le Verrier proposes to furnish ordinary standard time by telegraphic communication to all the public clocks of Paris.

The observatory of the University of Moscow, Russia, has published the second volume of its annals, which contains valuable photographs of a series of sixteen drawings of the belts of Jupiter, and of the physical appearance of Coggia's comet.

The Melbourne Observatory has published the first "Melbourne General Catalogue of Stars."

Mr. C. W. Pritchett has received an endowment of $30,000 for the observatory of the Pritchett Academy, at Glasgow, Missouri. The observatory possesses one of Alvan Clark's 12-inch equatorials.

The observatory of the Lehigh University, at Bethlehem, Pa., organized by Professor A. M. Mayer, has secured Mr. Doolittle as astronomer. Mr. Doolittle was formerly on the Northwestern Boundary Survey, and hopes to make good use of his present opportunities.

The observatory at Gettysburg, Pa., has been placed in charge of Professor P. H. Bickee.

Mr. Sayce has given some interesting items with reference to the early history of astronomy among the Chaldeans. According to him, astronomy was brought to this people by the Acadians, who, when they came westward from the mount-

ains of Elam, found a cognate race already settled in Chaldea. Having with them built the great cities of Babylonia, they were themselves subsequently, between the 30th and 40th centuries B.C., conquered by the Semites, who are known to history as the Chaldeans. By this ancient people the divisions of the zodiac, the days of the week, the months, and the year were established. Four and sixty were their most favorite subdivisions and multiples.

Mr. T. J. Lowry, of the Coast Survey, describes a new instrument based upon the principle of the sextant, by which two adjacent angles can be at once measured by one observer. It therefore allows one person, by observing three distant stations, to fix his position in the three-point problem; the new instrument will doubtless prove of great service in surveying.

Mr. Christie states that he has been employing for a year past the photometer invented by him, and finds that the probable error of a stellar magnitude is only the twentieth part. A feeble red star is, according to him, more easily distinguished than a feeble blue star.

It is proposed, on the occasion of the celebration of the centenary of the Genevan Society of Arts, founded in 1776, to distribute prizes to the makers of those chronometers which withstand the somewhat severe test applied by the committee of examination.

The astronomical necrology embraces Mr. Henry Twitchell, who died on the 26th of February at Cincinnati, at the age of 59. Mr. Twitchell was for twenty years the honored assistant and the principal observer at the observatory of that city. Strictly speaking, he was the contriver of the first chronograph ever constructed.

Hofrath Hennert Schwabe died, at the age of 85, at Dessau, Germany. His discovery, after forty years of observation, of the periodical nature of the phenomena of the solar spots, will long remain a brilliant example of the value of persevering observations.

The Sun.—The most important researches on the solar phenomena have been those of Professor Langley, of Pittsburgh. As the result of some six years' patient observations he has been able greatly to add to our knowledge of the peculiarities of the sun. After having succeeded in optical

analyses of the structure of the solar surface, as was explained in the *Annual* for 1874, he has now called to his aid photometry and the thermo-electric pile. He finds that the nuclei of the solar spots are cooler than the neighboring bright portions of the sun's surface, but in general warmer than the limb of the sun as seen through the solar atmosphere. He has, moreover, shown that the light and heat which we receive from the sun emanates from the superficies of the nucleus, which is covered by a thin layer of gaseous material, which latter absorbs both heat and light; but in so doing exercises a distinct selective power in that the absorption of the lower or heat rays of the spectrum is to the absorption of the visual rays as one to six. He finds, moreover, that a sensible amount of heat is received from those portions of the lower envelope that are distant thirty seconds of arc from the visible limb of the sun.

Pickering and Strange have investigated, photometrically, the amount of light absorbed by the solar atmosphere. The probable error of the result is exceedingly small, and shows that the light at the edge is about four tenths of that at the centre. It appears to them that there is a slightly different distribution of the light across the polar and the equatorial diameters.

Professor Mayer has continued to develop his method of obtaining the isothermals of the solar disk, and is now having a telescope arranged for the purpose of making continuous observations in this novel and interesting field. He suggests that the discordance in results obtained by Secchi and Langley may possibly be due to the fact that these observers have thrown the image of the sun upon inclined instead of horizontal disks of paper, thereby introducing superficial currents of air, whose presence he found extremely deleterious to his own results, and which were almost entirely obviated by employing a perfectly horizontal plane of projection.

Although our review strictly begins with November, 1874, yet we will not omit to notice the work of Violle, published a little earlier than that date, on the effective temperature of the sun. Assuming that the mean emissive power of the sun is sensibly equal to that of steel in fusion, Violle concludes that the true temperature of the sun is about two thousand degrees.

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Fuhg has published a discussion of numerous observations of the diameter of the sun, and finds no difference between the polar and equatorial diameters. The views of Father Rosa as to the variable diameter of the sun have been already noticed by us. These views have been lately defended by Secchi, as the editor of the posthumous papers of Father Rosa.

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double stars: a work which he did not live to complete, but bequeathed in its incomplete state to the Royal Astronomical Society, by whose authority it has been published as a catalogue of 10,300 multiple and double stars. A most important portion of this work was left uncompleted by its author, and has not been published by his editors. We refer to the descriptions of the distances, magnitudes, and colors of the stars. This important defect in the work, as it now stands, will, we have reason to hope, soon be supplied by the publication by the Naval Observatory at Washington of a far more important catalogue of double stars that has been in process of compilation during some years past by Mr. Burnham, of Chicago. This gentleman, by far the most industrious amateur astronomer in this country, has continued to make numerous contributions to this branch of astronomy, his labors being confined to the detection of new and extremely difficult companions to well-known stars.

The Hamburg Observatory has issued its first official publication in the shape of a memoir by Helmert on the stars of the cluster in Sobieski's Shield, the same cluster which was studied by Lamont in 1836. But slight movements of the individual stars can be deduced from a comparison of Helmert's and Lamont's observations, although they were separated by an interval of forty years.

Nebulæ.—The nebulæ have been studied of late from several points of view. Drawings of the more famous ones have been made in the United States at Washington by Holden, and at Cambridge and Washington by Trouvelot. In the southern hemisphere we note several contributions by Ellery at Melbourne.

The question of secular changes in the appearances of nebulæ can, it would seem, be best decided by making careful drawings of them at the present time as seen through telescopes of very feeble power, such as were necessarily used by the early astronomers. In this way Temple has traced the outline of the nebula near Merope, describing it as elliptical; while Wolf, at Paris, using a somewhat larger telescope, perceived two nuclei distant seven seconds from each other. Stephan having been unable to discern the nebula with his large telescope during the winter of 1874–5, it has been concluded that this nebula is certainly variable.

One of the most valuable catalogues of nebulæ yet published is that of Schultz, of Upsala, who has observed the exact positions of about five hundred of these bodies with reference to neighboring stars, thereby preparing the way for determinations, to be made possibly a hundred years hence, of the proper motions of these nebulæ.

PHYSICS OF THE GLOBE.

Tides.—One of the most useful works that has appeared of late years on the subject of tides has been published by the Coast Survey. Its author, Professor Ferrel, has given in detail the formulæ needed in the discussion of long series of tidal observations, and has treated specially the subject of shallow water tides. Professor Ferrel has also been able to deduce the mass of the moon with a high degree of accuracy, after taking account of the influence of friction.

Mr. Rohrs, in a paper on tidal retardation, has discussed the problem of maximum retardation on a globe entirely covered by a sea whose depth is constant for all points in the same latitude, but varies from the equator to the poles.

Sir William Thomson announces his conclusion that the much-vexed question as to the generality and correctness of Laplace's tidal investigations must be at last decided in favor of that great mathematician, and that therefore Airy's criticism falls to the ground, as also that of Ferrel. Airy's reply to Thomson will probably serve to prolong the discussion of this obscure but highly important question.

Seismology.—The investigations of La Saulx upon the earthquakes of Western Prussia have led to the authorization by the Prussian government of the establishment of a large number of seismometric stations in the volcanic region near Bonn.

Rev. O. Fisher has communicated a paper to the Cambridge Philosophical Society, in which he states that his attempt is to arrive at more definite conclusions in regard to the elevating force which has raised mountain ranges and caused the wrinkling of the crust of the earth.

The earthquake phenomena of Southern Austria have been elucidated in a valuable memoir by Suess, who shows that the centres from which earthquakes emanate are. in that

country, all ranged along certain straight lines or belts, which, in one remarkable instance, coincides with a river valley so perfectly as to afford the basis for very plausible speculations as to the dependence of the earthquakes upon the infiltration of surface water.

A series of terrible earthquake shocks is reported to have occurred in the month of May in the province of Borussa, in Asia Minor. Hundreds of houses have been destroyed and lives lost.

Perrey has published another great catalogue of earthquakes; the present volume being especially devoted to the year 1871.

The minute vibrations that for some days attend and generally precede severe earthquakes have been especially observed and studied by Serpieri, who in "Meteorologia Italiana" gives some of his conclusions as to the use of the pendulum seismograph in predicting earthquakes.

Terrestrial Magnetism and Auroras.—One of the finest publications in the department of terrestrial magnetism is the quarto volume recently received from the observatory at Trevandrum. This is the first of a series of volumes published at the expense of his Highness the Maharajah of Travancore. Dr. Broun, who was the director of the observatory from 1852 to 1865, is the editor of the present volume, and in it he has given a fine example of the good results that may be obtained by a careful study of every possible source of error in the instruments and observations.

Equally extensive is the large quarto published by the Dutch government in Java, and giving in detail the magnetic and meteorological observations made from 1866 to 1870 at Batavia under the direction of Bergsma. Many general results are given in the Introduction to this volume, and the whole contains a most important contribution to our knowledge of the climate of that portion of the Pacific Ocean.

The subject of "terrestrial electricity" has been studied on a grand scale by Schwendler, electrician to the Indian government. Over ten thousand observations made under his direction during the past six years on telegraph lines in India have shown that there is a uniform ground current from east to west, and have paved the way for improved methods

of investigation, which it is believed have, ere this, been authorized by the Indian government.

One of the most valuable contributions to the literature of the subject of auroras consists in the new general catalogue of auroras compiled by Fritz, of Zurich, and published by the Vienna Academy of Sciences. This author has added even to the great catalogue of Lovering, in that he had access to documents now for the first time rendered accessible. He has employed the great mass of data collected by him in a minute investigation into the geographical distribution of the aurora, and concludes that auroral frequency has to do with the distribution of ice in the arctic regions.

Highly interesting auroral observations have been made on the auroras by Tromholdt, who concludes that there is a connection between auroras and halos; but the most valuable contribution on this subject is from Weyprecht, in the preliminary reports on the results of the Austro-Hungarian North Pole Expedition of 1872 and 1873. According to him, very intense auroras were invariably followed by storms. Quite regular arches, without color or radiation, exercised no apparent influence on the needle.

METEOROLOGY.

Observers, Institutions, Instruments, etc.—Of government establishments, the most important change has been that at the Hamburg Seewarte, which has been purchased by the German government. The "German Seewarte" at Hamburg is now organized as an office of the Royal Hydrographic Bureau. To it are assigned the duties, first, of caring for ocean meteorology and the interests of navigation; second, of showing storm warnings on the German coast; and, third, the investigation of the meteorological conditions on which storms depend. It seems to be intended to abandon all studies of climatology, and to restrict its field of activity quite exclusively to simultaneous observations of the atmosphere, or to meteorology proper.

The meteorological service of Bengal, under Mr. Blandford, has begun the publication of daily weather maps for the Indian provinces. Reports are published daily, in addition to the bulletins, showing the weather. The reports of 145 rain-gauges, in addition to six first-class and ten second-class stations, have been published.

These will form an important extension of the maps which Meldrum began to compile in 1854 for the whole Indian Ocean, and which it is understood he still keeps up.

The meteorological office of the Argentine Confederation having been organized by Dr. B. A. Gould, he has continued to maintain a general superintendence of its work; and from his report of its activity during the year 1874, it appears that seventeen stations are occupied by him; his general rule will be, as he states, excellence in a few researches, rather than a wider range of inquiry with a probable sacrifice of accuracy.

The Russian government, following the lead of France and Germany, has decided to establish at Pavlosk, near St. Petersburg, a new physical observatory, in connection with the central physical observatory in that city. In Japan, the department having in charge the island of Jesso has taken steps to have regular meteorological observations made therein. These will be in charge of Professor Rockwell, of Tokio.

The organization of French meteorological departments continues to progress. The southern Mediterranean region has for its central office Montpellier. The northern Mediterranean region is centralized at Marseilles. For the western and southwestern regions a special meteorological congress has been called, to be held at Poitiers.

The report of the proceedings at London of the Conference on Maritime Meteorology, in that it gives succinctly the recommendations of the Vienna Congress, is well worthy of reference to the attention of American navigators and observers.

An excellent manual of instructions for the use of observers, accompanied, of course, with convenient tables, has been published by the London Meteorological Office. In some respects its directions differ from those recommended by the Meteorological Congress at Vienna; and, in fact, we seem to be as far as ever from realizing that absolute uniformity of methods and instruments which would be so conducive to the progress of science.

Dr. Mills communicates to the Physical Society of London some suggestions on thermometry. For thermometers which have not been used, the zero-point error must always be determined immediately after experiment. It is also generally

necessary to correct for the projection of the stem of the thermometer beyond the bath in which the bulb is immersed. The author, having made nearly two thousand observations for each of the instruments used by him, concludes that the well-known expression given by Regnault does not agree with his experiments; he shows the exact nature of the errors of his own instruments, but concludes that every observer must make a similar investigation of his own thermometers.

Among the numerous new methods of mechanical registration of atmospheric phenomena, especial attention seems to have been secured for the meteorographs of Baumhauer, Rysselbergh, and Secchi.

An excellent self-recording mercurial barometer is described by Redier; and a mega-barometer, or one that measures the pressure of the air at any moment on an enlarged scale, has been constructed by Hirn.

Among self-recording thermometers, the most peculiar is that of Mr. Cripps, which is so constructed that the movements of the mercury in the tube of the thermometer disturb the position of equilibrium of the whole instrument, inasmuch as it is delicately poised on two pivots. The consequent movement, which is due essentially to the force of gravity, is made serviceable for the purpose of registration.

Constitution of the Atmosphere.—Williams has made a photometric investigation into the intensity of twilight when the sun is at various distances below the horizon. He finds that at one minute after the sun sets the intensity of the radiation is $\frac{95}{100}$; at ten minutes after sunset it is $\frac{34}{100}$. Both this and the following investigation give us a means of expressing relatively the amount of moisture in the air.

Crosby, of the Massachusetts Institute of Technology, has made some photometric determinations of the light of the sky at different distances from the sun. The results, represented graphically, show a logarithmic curve when the intensities are plotted as ordinates, and the natural sines of the sun's angular distance as abcissæ.

The application of the spectroscope to the determination of the quantity of moisture in the atmosphere has been simultaneously studied independently by De Sains, in France, and Tait and Smythe, of Edinburgh. The latter agree that

certain fine telluric lines in the solar spectrum become dark smoky bands when the quantity of moisture is abnormally great.

Schöne has given some careful measurements showing the presence in minute quantities of the hyperoxide of hydrogen in the atmosphere; and Dr. Ecke has published an extensive investigation into the relative quantities of oxygen in the air, and in the different climates and at different seasons. His studies have special reference to the sanitary advantages of certain localities.

Temperature of the Air.—Dove contributes to the Berlin Academy a valuable paper on the climatology of Germany, based on observations of temperature made during twenty-five years, from 1848 to 1872, at two hundred and six stations.

Celoria elucidates the general laws of variations of temperature, both annually and daily, by one hundred and ten years of observations at Milan.

From the examination of forty years of observations of the temperature at Brussels, Quetelet finds that the so-called cold days of May actually exist for that place, giving rise to a well-marked depression, amounting on the average of the whole period to three degrees of temperature.

Silbermann has observed the temperature of a small mass of black powder exposed to the sun's rays, and has applied his results to explain the cases in which the northern sides of mountain chains are more fertile than the eastern sides.

In reference to the production of frost, Ley states that a study of the upper currents of the clouds has shown him that, at least in England, frosts are preceded by a slight backing of the upper southwest and northwest currents.

Barometric Pressure.—The relations between the barometric pressure and the velocity of the wind have formed the subject of valuable contributions to the Journal of the Austrian Meteorological Association, where Hann has developed the mechanical formula of Ferrel, and given a translation of the work of Colding, of Copenhagen; the latter shows the perfect agreement of his formula with observations made during certain hurricanes in 1837 and 1871. Mr. Ferrel's formulæ are, however, preferable to Colding's.

A very complete review of the state of our knowledge with respect to the connection between barometric pressure and

rainfall has been published by Hann, who has shown that we have no reason to believe that the condensation of atmospheric vapor directly causes large observable changes of pressure. In order, then, to understand why so great depressions of the barometer are observed in the midst of every storm, he finds it necessary to adopt the mechanical principles which have been developed so fully by Ferrel and others, and which have been adopted by some of the American meteorologists for many years.

In the application of the barometer to hypsometric purposes, we notice the empirical tables prepared by Professor Whitney and Mr. Pettee especially for the climate of California, which give corrections to be applied to the results of computation by the ordinary formulæ, in order to obtain more correct altitudes.

Winds.—The report of the permanent committee appointed at the Meteorological Congress at Vienna has recently been received, in which is given the proceedings of the meetings held by the committee, and in the appendix the papers communicated to it by the meteorologists of Europe. Among these, the greatest interest will attach to the short preliminary reports by Buys Ballot, of Holland, Wild, of Russia, and Scott, of England, on the relation between the velocity and the force of the wind. An investigation of the same subject has also just been published by Hagen, of Berlin; and from his own, as well as the other papers referred to, it seems certain that the friction of the air blowing past the edge of a plain circular disk brings about an increase in the pressure experienced by that disk. So that the pressure is not, as ordinarily assumed, proportional to the area of the disk and the square of the velocity of the wind, but may be said to depend upon the circumference of the disk, and upon other powers of the velocity. A fuller investigation of this subject will be necessary before we can at all understand the effects produced by the power of the winds of tornadoes and hurricanes. The complete memoir by Dohrandt and Wild, of St. Petersburg, will be found in Wild's "Repertorium."

An important memoir by Blandford has been published under the title of the "Winds of Northern India," which, however, contains much more than the title would seem to indicate.

The relative direction of the movement of the upper and lower strata of the atmosphere has been carefully studied in Northern Europe by Hildebrandsson, who concludes that the higher currents of air are always directed toward points to the right hand of the lower currents, an expression which is much more general than that adopted by Hildebrandsson himself, but which will be found to be fully warranted if we compare the works of Redfield (1837), Ferrel (1859), Abbe (1871), and Ley (1872).

Storms.—Mr. W. C. Ley, well known by his valuable work on the barometer and the winds, states that, having worked for a considerable time at a comparison of the weather charts of the United States and Europe, he is convinced that only a small portion of the storms experienced on the American side of the Atlantic can subsequently be distinctly traced in Europe; and of these the majority are felt severely, not in Great Britain or France or Denmark, but in the extreme north of Europe. Many of the most destructive European storms occurred when the barometric pressure on the eastern coast of America was tolerably high and steady. They appeared to be developed on the Atlantic Ocean near the eastern limit of the area of high pressure. He does not believe in the utility to Europe of a system of storm predictions sent from North America, though it does not appear but what others may be in possession of the knowledge which Mr. Ley has not, and which would make such predictions invaluable to France and England.

The storms of the United States have continued to be especially studied by Professor Loomis, of Yale College, who has based his studies, as heretofore, on the daily maps of the Army Signal-office. He finds that centres of low barometric pressure tend to move toward centres of high pressure when the latter lie to the southward, but move from them when they lie to the northeastward. He concludes that about one tenth of our storms reach the European coasts.

In reference to the display of storm signals, we note that these are now shown from every important point along the whole German coast. The French system of storm warnings has experienced a new organization, dating from the 1st of March. The British system reports a percentage of eighty-four per cent. of verified storm warnings.

One of the most important publications of the year is the "Bulletin of International Simultaneous Meteorological Observations," published by the Army Signal-office Weather Bureau. This bulletin gives in detail the observations made at 7.35 Washington time simultaneously throughout the world. When entered upon a weather chart, we shall now have the means at hand for a comprehensive study of the movements of the atmosphere throughout the globe, we shall doubtless frequently be able to trace storms in their progress from America to England, and shall study the dynamics of the atmosphere on the proper scale.

The study of the atmosphere by means of balloon voyages has been diligently prosecuted. The only disastrous scientific voyage has been that of the *Zenith*, whose ascent on the 15th of April last was signaled by the death by asphyxia of two of the aeronauts—Croce Spinelli and Sivel. Notwithstanding this misfortune, De Fonville has resolutely carried out several experiments looking to the solution of any mystery that might have attended the death of those aeronauts; and he shows conclusively that they must have died of suffocation due to the rapid flow of gas from the ascending balloon. De Fonville maintains that balloon ascents may be made, if conducted gradually, to immense altitudes, even greater than those reached by Glaisher.

A very important branch of the insurance business is, in Europe, confined to the issuance of policies against damages by hail-storms. From a recent publication by the Wurtemberg Bureau of Statistics, it appears that during the forty-six years ending in 1873, thirty-five per cent. of the hail-storms have occurred in July, and twenty-eight per cent. in June, and less than one half per cent. in February and April; the earliest occurring on February 9, and the latest on September 25. Ten different years are enumerated in which damage to the extent of two million florins was reported by the insurance companies, while five years occurred in which the damages were less than five hundred thousand florins. The districts most frequently visited were the outlying spurs of the Alps. A comparison of the whole series shows that in Carinthia and in Wurtemberg a certain agreement exists as to the variable frequency of hail-storms in separate years, pointing to some common cause other than local influences.

In connection with this subject, we note the announcement recently received by us of the death, on the 18th of March, of J. Prettner, who, although director of an extensive manufactory of white-lead, found time to carry out most excellent climatological investigations in reference to his own country, and whose work on Carinthia has been quoted in the preceding sentences.

The vexed question of the influence of forests upon rainfall has been the subject of study of Fautrat and Sartiaux, whose observations have been made especially in the forest of Hachette, France. Their instruments were placed above the tops of the trees in the midst of the forest, which covers twelve thousand acres, and also at a similar elevation above the surface of adjoining portions of cleared land. The total rainfall over the forest was always larger than that over the cleared land; whence they concluded it to be demonstrated that forests form a vast apparatus for the condensation of moisture, and that there is more rain upon them than upon open land. We fear, however, that this conclusion will not bear the test of a very slight criticism, notwithstanding the value that must attach to the observations themselves.

Rev. C. Dade has examined the record for forty-one years of the weather in Canada with reference to the truthfulness of the popular saying, "Saturday's moon, the winds full; never was fair, and never will." He finds that the number of days of clear weather during the twenty days after a Saturday's full moon is quite the same as the number of days of clear weather for twenty days after a Saturday's new moon. The popular saying is therefore completely contradicted by actual observations; and further investigations into the connection between the phases of the moon and the weather will only confirm that conclusion which has so frequently been drawn by previous investigators that there is no perceptible connection between the moon and the weather.

PHYSICS.

The progress in Physics during the year has been marked. In *General Physics*, Clerk-Maxwell's lecture before the London Chemical Society upon the dynamical evidence of the molecular constitution of matter is to be noted, since it presents in an admirable way the conclusions which have been

reached on this subject by mathematicians who have studied molecular physics.

Töpler has given an extended illustrated description of the admirable new physical laboratory which has just been erected by the Austrian government at the University at Grätz.

In *Mechanics*, Professor Sylvester states that by the study of linkages he has been led to the conception of a new instrument, by means of which a figure in the act of being magnified or reduced may at the same time be slewed around the centre of similitude. This instrument may be used, therefore, to transfer a figure from one position on a sheet of drawing-paper to any other position upon it, leaving its form and magnitude unaltered, but its position slewed around through any desired angle. Again, it enables us to apply the principle of angular repetition, to produce designs of complicated and captivating symmetry from any simple pattern or form, such as a flower or sprig; and still it may safely, by practice, be found to place a new and powerful implement in the hands of the engine turner, pattern designer, and the architectural decorator.

Rood has described in full the important modifications he has made in Zöllner's horizontal pendulum, and has given the extraordinarily delicate measurements he has made with it. The mean probable error of the average result of four sets of observations made with the apparatus is one tenth of a scale-division, corresponding to one thirty-six millionth of an English inch! Rood purposes to use this remarkable instrument for the purpose of studying minute changes, otherwise inappreciable, in the dimensions of solid bodies under various conditions.

Pfaff has made some experiments upon the plasticity of ice, in order to throw additional light upon glacier motion. In none of the hitherto recorded observations is any mention made of the amount of pressure necessary to change the form of ice, though Moseley observed that to pull apart an ice cylinder a weight of five and a half to nine atmospheres was required to the square inch, and to fracture it a pressure of seven and a half to nine atmospheres. Pfaff has sought to determine the minimum pressure at which ice yields, and has proved that even the slightest pressure is sufficient if it act

continuously, and if the temperature of the ice and of its surroundings be near the melting point. In one experiment a hollow iron cylinder 11.5 millimeters in diameter sunk into the ice 3 millimeters in two hours, it being surrounded with snow, the temperature varying from $-1°$ to $+0.5°$. When the temperature rose above the melting point, it sank 3 centimeters in one hour! scarcely a trace of water resulting. A steel rod a square centimeter in section, when pressed with one third of an atmosphere, sank into the ice 14 millimeters in three hours, the temperature being 2.5°. The flexibility of ice was shown by placing a parallelopiped 52 centimeters long, 2.5 centimeters broad, and 1.3 centimeters thick upon wooden supports placed near its ends. From February 8 to 15, the temperature varying from $-12°$ to $-3.5°$, the middle portion sank only 11.5 millimeters. But the succeeding twenty-four hours the temperature was higher, and the middle of the bar sank 9 millimeters. From 8 A.M. to 2 P.M. the increase was 3 millimeters, when the bar broke, the temperature being $+3°$. The whole bending was 23.5 millimeters. Similar experiments were made upon the ductility of ice; it elongated by traction. From these results it is easily seen why a glacier's motion increases with the temperature.

Professor Nipher has made an elaborate investigation upon the mechanical work done by a muscle before exhaustion, the data given being more accurately determined than those published by him three or four years ago, and adopted as a basis for calculation by Professor Haughton, of Dublin.

De la Bastie has communicated to the Société d'Encouragement an account of his new process of tempering or hardening glass. The manufactured articles are heated to near the temperature of softening, and then cooled suddenly in a suitable bath of oil. The glass thus treated becomes extraordinarily resistant, in some cases amounting to fifty times that of ordinary glass. It becomes also very hard, so that difficulty is experienced in cutting it with a diamond. Though so resistant, it is very brittle. A piece when broken flies into a thousand fragments, exactly like the well-known Prince Rupert's drop. Vessels were shown of the new glass in which water could be boiled over a naked fire without fear of breaking them. Upon plates of it a weight of one hundred grammes was allowed to fall from a height of three

and a half meters without fracture. Watch-glasses made of it remained intact when thrown across the room. The hardening process is not difficult nor costly, and it promises to become of great practical importance. Mr. Pockington states that he has examined by polarized light some specimens of this hardened glass, prepared by himself according to De la Bastie's method. Having prepared a small cube in this manner, its sides were ground plane and polished, and on examination by the polariscope it became at once evident that the contraction of the exterior of the mass must exert a powerful compressing force upon the interior. The outer surface of the glass can be made, according to his experiments, nearly twice as hard as ordinary glass. On grinding away either surface it is evident that the interior of the mass consists of ordinary glass, being little, if at all, harder than before the application of De la Bastie's process, and subject to fracture in the ordinary way. There appears to be a limit beyond which the opposite surfaces can not be unequally removed without producing such phenomena as, under the polariscope, show the existence of unsymmetrical tensions; but there is practically no limit beyond which both surfaces may not be simultaneously removed, as is shown by dissolving away the softer portions by means of hydrofluoric acid. De Luynes and Feil—the former well known from his researches on the Prince Rupert's drop—have also made some experiments on the hardened glass of M. De la Bastie. They find that this glass presents many points of analogy with the Prince Rupert's drop, as well in the mode of production as of fracture. Though it is not ordinarily possible to cut a piece of this glass with a saw, a drill, or a file without its flying in pieces, yet in some cases it may be done. A disk, for example, may be drilled through its centre without fracture, though not elsewhere. A square plate of St. Gobain glass thus hardened showed in polarized light a black cross, the lines of which were parallel to the sides. It is always possible to saw such a plate along these lines without fracture, though beyond them, either parallel or transverse to them, any attempt to cut the plate fractures it. If the two fragments of a plate thus cut be examined in polarized light, the arrangement of the dark bands and colored fringes shows the molec-

ular state to have altered by the division. Placing the one plate directly upon the other in the original position, both bands and fringes disappear; while if reversed and superposed, the effect is increased, being that due to a plate of double thickness; hence the tension in the plate is symmetrical with reference to the saw-cut. We may conclude, therefore, that while hardened glass is in a state of tension, it may always be cut in certain directions when the resulting pieces can take a condition of stable equilibrium. This is easily determined by examination with polarized light. In the case of fracture the fragments are always symmetrically arranged with relation to the point where the equilibrium was first destroyed. The authors have also examined into the cause of the bubbles so generally seen in hardened glass. They find them to be produced at the moment of hardening, and to disappear, or nearly so, when the glass is annealed. They hence conclude that they are due to the imprisoning of minute masses of gas in the glass, these masses becoming enormously dilated when the glass is hardened; this dilatation, which is actually seventeen or eighteen hundred times the original volume, being caused by the contraction of the surrounding glass produced in the process of hardening.

Boudreaux has published a simple and more general method of demonstrating the Archimedean law of buoyancy in liquids. A glass vessel with a slightly conical lateral spout is placed beneath the pan of a hydrostatic balance, to which is suspended the body to be experimented upon. This vessel is filled previously, the excess of liquid being allowed to flow off through the spout. Two thin capsules are then provided; one of them is placed on the pan supporting the body, and is balanced by shot. The body is then immersed, the overflow of liquid being collected in the second capsule. The inclination of the balance beam shows the upward pressure. But on replacing the first capsule by the second, which contains the liquid displaced, the equilibrium is restored.

Carl has devised a simple apparatus for showing lateral pressure in liquids. It consists of a cylinder to hold the liquid, hung at its top upon a knife edge, and having a lateral opening near the bottom which can be closed at pleasure. An index attached at the top moves over a graduated scale as the cylinder varies from perpendicularity. The condition

of equilibrium is regulated by one superior and two lateral balls. If now the cylinder be filled with water, it remains perpendicular; but on opening the orifice at the bottom the water pressure is relieved on that side, and the cylinder swings in the opposite direction. The apparatus may be made to show also the change in the form of the parabola as the height of the water column decreases.

Paquet has described a new densimeter, which is simply the instrument of Rousseau modified so that it can be used for solids. An ordinary hydrometer has an enlargement upon the top of the stem about half a square centimeter in section and fifteen centimeters long, closed at the lower end, and divided into cubic centimeters and tenths. A zero point is marked at the level of the second centimeter mark, and the instrument is so weighted that when the upper tube is filled with water to the zero level, it sinks in water to the bottom of the stem. To the water in the upper tube a definite weight, the maximum ever to be needed, is added—say, six grammes. The instrument sinks to a certain point, which is noted on the stem and marked 60, and the stem is divided between this mark and zero into sixty equal parts, the divisions being continued up if there is space. Each division corresponds to one decigramme. To use the instrument, two cubic centimeters of water are placed in the upper tube, and the whole immersed in water, sinking to zero. The fragment of mineral, for example, to be determined is placed in the water in the upper tube, and thereby raises its level three divisions; the volume of the fragment is therefore 3 c. c. The instrument sinks by the increased weight, say, to the fifty-fifth division; hence its weight is 55 decigrammes or 5.5 grammes. The specific gravity is 5.5÷3, or 1.83, therefore.

Arzberger and Zulkowski have proposed a new form of water air-pump, founded on the principle of the increased flow of liquids caused by an ajutage like an inverted frustrum of a cone. By a lateral opening, water, under considerable pressure, enters a small cylindrical box, upon the top of which is the air tube, entering about half-way, and narrowing to a point. This enters and opens into the narrow end of a slightly conical tube called the diffuser, which projects several inches below the box, and by which the water issues. The supply of water must keep the tube full, and as it wid-

ens downward there is an exhaustion. With 585 mm. of mercury pressure of water, the barometer standing at 735 mm., the vacuum produced was 724 mm., and the consumption of water three liters per second. No fall of water is necessary, the pressure being all-sufficient.

Lippmann has published *in extenso* his important memoir on the relations between electric and capillary phenomena. In it he establishes the following important laws: First, the capillary constant at the surface of separation of mercury and dilute sulphuric acid is a function of the electric difference which exists at this surface; and, second, when by mechanical means a liquid surface is made to change its form, the electric difference of this surface varies in such a way that the superficial tension developed in virtue of the first law opposes the continuance of the movement. These laws he has ingeniously applied, first, to the accurate measurement of capillary constants, hitherto so uncertain; and, second, to the measurement of electro-motive force by means of his capillary electrometer. His ingenious electro-capillary motor, which shows the direct conversion of electrical into mechanical energy by means of capillarity, is also fully described.

Terquem has published an historical note, in which he calls attention to the fact that the generally received notion that Faraday was the first to liquefy the gases is incorrect, since Guyton de Morveau in 1799 liquefied ammonia gas in a bath of calcium chloride and snow.

Exner has made some quantitative experiments on the penetration of liquid films by gases. He finds that the velocities of diffusion are directly proportional to the coefficient of absorption of the gas for the liquid composing the film, and inversely proportional to the square root of the density of the given gas. Adopting air as the unit of comparison, the relative velocities are—for nitrogen, 0.06; oxygen, 1.95; coal gas, 2.27; hydrogen, 3.77; carbonous oxide, 47.1; hydrogen sulphide, 165; ammonia, 46,000. As to the absolute velocity, Exner finds that 1.88 c. c. of hydrogen and 0.55 c. c. of air diffuse simultaneously through each square centimeter of the soapy film.

G. von Liebig has contrived an exceedingly useful modification of Frankland's apparatus for gas analysis, in which the measurements are made, not by measuring the volume

under equal pressures, as is common, but by measuring the pressures, the volumes being made equal. It is simple in construction, satisfactory in operation, and accurate in its results.

ACOUSTICS.

In Acoustics, Lissajous has described in the *Bulletin de la Société d'Encouragement* an elaborate machine for tracing mechanically the curves which represent the composition of vibratory movements, constructed by Froment. The driving-shaft carries toothed wheels, gradually increasing in size from right to left. Upon the pinions driven by these, which are arranged in pairs, are eccentrics, which by means of connecting rods give a differential to and fro motion to an arm transverse to their direction. To the centres of two contiguous arms two other connecting rods are attached, which move a transverse arm of the second order, and similarly an arm of the third order is thus moved, which carries the style. The motion of the style is therefore the algebraic sum and resultant of the motion of the eight driving-wheels, and the curves it describes may be exceedingly complicated.

Schuller has contrived an apparatus by which Lissajous's figures may be readily produced on the screen. It consists of two pendulums, adjustable by sliding weights, carrying mirrors, each movable on a horizontal axis, at their upper ends. The planes of vibration may be parallel or perpendicular, at will. The same physicist has devised a modification of the common form of this experiment with tuning-forks. Instead of having a mirror on the extremity of a prong of each fork, he places the two forks with their four prongs in the same plane, one of the forks being vertical, and four or five inches in advance of the other, which is horizontal. The lower prong of the horizontal fork carries a screen with a small hole in it. The second fork carries on one of its prongs a small lens of short focus. The small opening in the screen is strongly illuminated by sunlight concentrated on it by a lens; an image of this is formed on a distant screen by means of the lens on the second fork. When the first fork is vibrating, a vertical line of light will appear; when the second is in motion, the line will be horizontal; when both are in action, the Lissajous curve corresponding to their rate will be given. The figures are much larger made in this way.

Decharme has given a novel method of producing sonorous vibrations. He simply blows a current of air through a tube, the lower end of which is just even with the surface of mercury contained in a suitable vessel. This yields a distinct sound, and at the same time the mercury is thrown into circular waves, producing a symmetrical network on its surface. The smaller the interior diameter of the tube, the more acute and feeble the sound and the finer the waves. He recommends, as the best, tubes between 0.8 and 5.0 millimeters in interior diameter, fixed vertically, and supplied by a uniform current of air. By having a series of properly selected tubes, the surface of the mercury may be made to assume any sets of waves and interferences; and by illuminating them strongly, they may be projected on a screen as an admirable lecture experiment. The same author has described a new form of sonorous flame. When gas under the ordinary pressure is burned from an opening three to five millimeters in diameter, a flame thirty to fifty centimeters in height is obtained. If now, by means of a similar tube held horizontally, a moderate current of air be directed against the flame, persistent and very varied sounds are produced. The experiment succeeds very well with a Bunsen burner giving a luminous flame (its air-openings being closed), the tube supplying the air being placed horizontally a little above the orifice and in contact with the flame. The phenomenon acquires special interest when viewed in a revolving mirror. In a subsequent paper he gives experimental reasons for believing that the air which is blown against the flame, and which he supposed to act solely mechanically, plays also a chemical part. He finds that, using a Bunsen burner, the sound is extremely feeble unless the air-openings be closed and the flame be luminous. Moreover, neither carbon dioxide nor nitrogen gases will produce the sound unless oxygen be mixed with it. The author hence believes that the sound results from the small explosions which are incessantly produced by the combination of the oxygen of the air with the carbon and hydrogen of the flame when the combustion of this is already incomplete. That the sound should be well-pronounced, therefore, the presence of air or of oxygen mixed with some inert gas is necessary.

Bresina has described a simple method of comparing the

rates of vibration of two sounding air columns by means of oscillating flames. To the jets supplying two ordinary singing tubes are affixed lateral branches, by which the gas from each may also be supplied to a second burner supported on a convenient lateral stand. When the flames in the tubes sing, those outside vibrate in unison with them; and by means of a revolving mirror the ratio of the two may easily be ascertained by counting. If the two singing flames are connected to the same exterior flame, the combined vibration is seen in the mirror.

Tyndall, in a communication to the Royal Society on acoustic reversibility, discusses the curious results obtained at Villejuif and Montlhéry in 1822, when cannonading at the latter station was heard at the former, but not the reverse, and concludes that Montlhéry must have been surrounded by a highly diacoustic atmosphere, while Villejuif was in an atmosphere acoustically opaque. He supports this position by ingenious experimental evidence.

Mercadier has printed a paper upon the law of the influence of the variation of the dimensions of a tuning-fork upon its vibrations, in which he shows that the number of vibrations is independent of the breadth, is directly proportional to the thickness, and is inversely proportional to the square of the length. From these laws it becomes possible to calculate within one or two per cent. the dimensions of a fork necessary to give any required number of vibrations.

Neyreneuf has shown very beautifully the oscillatory or vibratory character of the detonation of a mixture of oxygen and hydrogen gases. In a tube the result may be shown in two ways: either by making the tube perfectly dry inside, in which case the watery vapor produced by the combustion condenses preferably on the cooler parts of the tube, leaving those parts transparent which the vibrating flame has heated, or by coating the tube interiorly with a thin layer of paraffin, when the melting of this substance shows the heated portions. In these experiments it is necessary to graduate the rapidity of the combustion to the size of the tube. With a test-tube an inch and a quarter in diameter and eight inches long, well dried, and filled with a mixture of equal volumes of hydrogen and air, the striæ represented fern leaves. With tubes of less diameter, the effects are more regular, es-

pecially if during the detonation there is a musical sound produced. Fine striæ are then observed perpendicular to the axis of the tube. If the tube is very long, there is no musical sound produced, but the rings are widely separated and very sharp.

La Cour has devised a very ingenious use of the tuning-fork for transmitting signals on telegraph lines, which promises to become of great importance. It is based on the well-known fact that if a given fork be made to interrupt an electric circuit by its vibrations, and the intermittent current thus produced be passed through a series of electro-magnets, each in connection with a fork of different rate, only that fork will be thrown into vibration which is in unison with the first one. Practically the time required to do this is a small fraction of a second. The advantages of this method are numerous. Not only may many receiving instruments at one station be operated, each by its own key, through a single wire, but many different stations in the same circuit may be operated, that one alone receiving the message which has the requisite instrument. Moreover, many signals may in this way be transmitted over the same wire at the same time, and many dispatches sent simultaneously to as many stations. All this may be done, too, without affecting the line for its ordinary use, and independent of atmospheric and terrestrial currents. The system recently patented by Elisha Gray, of Chicago, is essentially similar in principle.

Mayer has published a redetermination of the durations of the residual sonorous sensations, in which he was assisted by Madame Emma Seiler and her son, Dr. Carl Seiler, of Philadelphia, well known in connection with similar researches of Helmholtz. It now appears that Ut_1 has a persistence of $\frac{1}{25}$ of a second, Ut_2 $\frac{1}{45}$, Ut_3 $\frac{1}{70}$, Sol_3 $\frac{1}{102}$, Ut_4 $\frac{1}{130}$, Mi_4 $\frac{1}{153}$, Sol_4 $\frac{1}{166}$, and Ut_5 $\frac{1}{180}$ of a second. The determination is not an easy one, owing to the production of secondary and resultant tones.

Pole has made an experimental determination of the change in the pitch of a note which takes place when the sounding body is moving—a repetition of the experiment of Buys Ballot. He used for the purpose locomotive whistles, and concludes that the most common interval by which the tone is lowered when two trains pass each other is a third,

either major or minor, corresponding to a speed for each of between thirty-five and forty miles an hour.

HEAT.

On the subject of Heat, Cailletet has further studied the effect of pressure on combustion, the experiments being made up to three hundred atmospheres. He finds that while the luminosity of a flame increases under pressure, the activity of the combustion actually diminishes; the temperature augments, but the oxidation lessens. An alcohol flame, ordinarily so pale, becomes as bright as that of a candle at twenty atmospheres. A candle flame under these conditions gives more light, but the wick soon becomes smoky from imperfect combustion—that which is gained on the one side being lost on the other.

Violle has called attention to the thermo-diffusion experiments of Feddersen and Dufour (which are properly such, since the diffusion of a gas through a porous diaphragm causes a rise of temperature on the side of the entering gas, and a difference of temperature on the two sides of such a diaphragm causes a diffusion of gas), in order to explain an experiment of Dufour, in which he used air in different hygrometric states on the two sides of the diaphragm, and observed the diffusion. Violle believes that the true explanation of this result is to be found in Merget's experiments, in which a porous cell, filled with pumice in fragments, and closed by a cork through which a tube passes, the whole being well moistened, develops, when exteriorly heated to a dull red heat, simply from the surface evaporation, a pressure of air in its interior of three atmospheres. Experiments of his own show how extremely sensitive is this apparatus to changes of temperature. The practical importance of these facts is very great. Our clothes, the stones of our houses, the very soil itself, when heated after previous moistening, act exactly like the apparatus of Merget, with an activity truly surprising. In animals this gaseous movement plays its part in respiration; but in plants, especially in aquatic plants, it is seen in full activity, *Nelumbium speciosum*, for example, throwing from its stomata half a liter of air per minute, solely through this action going on in its leaves.

Berthelot has published an important research, in which he

has studied the thermal changes produced when acids or alkalies are dissolved in water, with the expectation of solving the question of hydratation. He has also given a description in a subsequent memoir of the various pieces of apparatus which he has employed in his calorimetrical experiments. These are, a helicoidal agitator for mixing the water of the calorimeter, an *écraseur* for crushing salts and other solids in liquids, a distilling apparatus, with worm and receiver, for effecting reactions out of contact with water, an apparatus for measuring the heat of solution at elevated temperatures, a closed apparatus for the reaction of nitrogen dioxide on oxygen, and an apparatus for decomposing ammonium nitrite by heat.

Thomsen has made another series of investigations in thermo-chemistry, in which the heat of combination of manganese, zinc, cadmium, and iron has been determined. Combining these results with previous ones, it appears that for the nine metals which decompose hydrochloric acid with evolution of hydrogen, the heat of combination for every molecule of hydrogen thus evolved is, for lithium, 125,860 calories; for potassium, 123,700; for sodium, 114,380; for magnesium, 108,290; for aluminum, 79,880; for manganese, 49,360; for zinc, 34,200; for iron, 21,310; and for cadmium, 17,610 calories.

Boisbaudran has shown that a remarkable inequality of action is exerted by a given supersaturated solution upon different isomorphous bodies. A perfectly regular crystal of potassio-chrome alum, placed in a slightly supersaturated solution of ammonio-alumina alum—which had been rendered basic, so as to crystallize in cubes—was soon covered with a white octohedric envelope showing cubic facets. After a longer time the cubic facets had increased considerably, but the distances between opposite solid angles of the octohedron remained unaltered. Hence the author concludes that the solution must have been supersaturated relatively to the octohedral faces of the ammonio-alumina alum, but not relatively to the cubic faces of the same alum. In general it appears that in the phenomena of solution and crystallization, the molecular volume, the density, the relative arrangement of the similar or dissimilar atoms in the molecule, and all other causes of dissimilarity, possess their special influences.

Indeed, it may be said that two bodies not absolutely identical never exhibit strictly the same physical or chemical reactions, however closely they may in certain particulars resemble each other.

Pfaundler confirms the unequal solubility of different faces of the same crystal, remarked by Lecoq de Boisbaudran, and calls attention to his theoretical explanation of it, first published in 1869. He concludes that those faces of a crystal which possess favorable conditions for resisting the impact of the moving molecules are preserved and grow at the expense of the others. "Thus," he says, "the principle laid down by Darwin is applicable also in the world of molecules. Those forms and combinations which possess the most favorable conditions of existence are the ones which are preserved."

Boisbaudran has also shown that very low temperatures may be produced by means of the ammonia ice-machine of Carré by taking suitable precautions. If during the cooling the heater be surrounded with ice-water, or, still better, with a freezing-mixture, it is possible to obtain, even with a machine holding only half a liter, the rapid solidification of several kilogrammes of mercury. After the freezing of nearly five kilogrammes of this metal in a solid cylinder, the temperature within was found to be $-48°$. If ice and salt be added to the water in which the condenser is placed during the heating, it is not necessary to raise the temperature of the heater so high by ten or fifteen degrees.

Guthrie has given a curious paper upon hydrates (or hydrated salts) formed at a low temperature, which he calls cryohydrates. He shows, contrary to the generally received opinion, that the minimum temperature attainable by mixing ice with a salt is very independent of the ratio of the two, and of their temperature, and of the state of division of the ice. The temperature of a mixture of ice and a salt is as constant and precise as the melting-point of ice. He observes that the cryohydrates of the nine salts which potassium, sodium, and ammonium severally form with chlorine, bromine, and iodine, are formed at temperatures ranging from $-28°$ to $-11°$. Thirty-five salts were examined in this way, and it was found that the temperature at which the cryohydrate is formed is precisely that obtained by mixing the given salt with ice. In a subsequent paper he gives addi-

tional experiments upon salt solutions and attached water. He assigns the name *cryogen* to an appliance for obtaining a temperature below 0° C., and *cryohydrate* to the substance produced by the union of water with a body, this hydrate being capable of existence only below 0° C. He finds that of cryogens the best is a mixture of sodium bromide with three to six times its weight of ice finely divided, the temperature produced being —28° C. From an extended series of experiments, he concludes that "of similar salts, the one which produces the greatest cold when used in a freezing mixture unites as a cryohydrate with the fewest molecules of water." And again, "The temperature at which the cryohydrate is formed is the same as the temperature of the corresponding freezing mixture." Of special interest is the cryohydrate of ethyl alcohol, which is produced whenever a dilute alcohol is exposed to a temperature of —34° C., and has four water molecules united to one of alcohol. It separates from the liquid in crystals. Ether also forms a cryohydrate, solidifying at —2° C., and consisting of one ninth of ether. If the experiment be made in a long test-tube, the long candle-like mass, when removed, placed upright on a plate, and lighted, burns with a non-luminous flame, the heat being consumed in melting the ice.

Chaumont has experimentally investigated the question of ventilation, so far, at least, as the amount of air necessary for health is concerned. His determinations were made on the air of barracks, of prisons, and of hospitals; and he concludes from them that 85 cubic meters (3000 cubic feet) of air per head per hour is necessary in health, in ordinary diseases one third more than this, and in serious diseases and epidemics even more still.

Gernez has made an exhaustive research into the phenommena attending ebullition. His paper opens with a long historical note upon this subject. Then follows his own results, in which he studied (1) liquids heated in contact with solids, (2) within other liquids, and (3) the ebullition developed by mechanical action. He maintains that ebullition is an evaporation into some gaseous atmosphere contained within the liquid.

Troost and Hautefeuille have made a calorimetrical investigation on iron and manganese silicides. They conclude,

first, that silicon in combining with manganese evolves considerable heat, and hence that the compound thus formed is very stable—a fact already proved for carbon. Second, that the similarity of these two substances, carbon and silicon, appears also when their action on iron is considered; they both act as if they were dissolved in the metal.

Kundt and Warburg have obtained an interesting result in investigating the specific heat of mercury vapor. On the kinetic molecular theory of Clausius, the quotient of the specific heat of a gas at constant pressure, divided by the specific heat of the same gas at constant volume, should be 1.67, while, in fact, for most gases this quotient is only 1.405. Clausius explains this by the fact that molecules are not material points, but are composed of atoms; and only in a monatomic gas would there be a correspondence with theory. The molecule of mercury is shown by its vapor density to be monatomic; and it is now found by experiment that in the case of this vapor the above quotient is actually 1.67. Hence a molecule of mercury, so far as its theoretical and mechanical properties are concerned, acts like a material point.

Desains has continued his researches upon solar radiation, and has determined the quantity of heat received per minute at Paris by one square centimeter of the earth's surface placed normal to the direction of the rays during an entire year. The maximum was on June 22, when the amount received was 1.29 units, and the minimum on January 30, the amount being one unit. He finds also that the proportion of the solar rays transmitted by a layer of water eight millimeters thick reached its maximum on July 4, being 0.71, and its minimum on April 25, being 0.63.

Mayer has proposed a simple mode of obtaining thermographs of the isothermals of the solar disk by the use of Meusel's double iodide. Thin paper, smoked on one side, is covered on the other with the iodide, and is exposed to the sun's image, formed by a telescopic object-glass, the aperture being at first only that necessary to give the smallest area of blackened iodide with a sharp contour. This he calls the area of maximum temperature. On enlarging the aperture, the black area gradually extends, forming a series of new isothermal lines with the successive enlargements. Some interesting conclusions have already been reached, and it is

the author's intention to make a thorough investigation of the vast field thus opened.

Lundquist has given the results of his calculations to determine the distribution of heat in the normal sun spectrum, founded on certain measurements of Lamansky's. He represents the intensity of this heat graphically, and gives curves in which the ordinates represent intensities, and the abscissas wave lengths. It appears from these curves "that in the normal spectrum of the sun the maximum of heat is situated about in the middle of the luminous spectrum, and diminishes on both sides of this point," thus confirming entirely the experimental results obtained by Dr. John W. Draper in 1872. In the electric spectrum, however, assuming Tyndall's results as data, calculation gives a curve in which the maximum of heat is near the line A. In this case the distribution of heat is not equal in both halves of the visible spectrum.

Hoorweg has repeated with great care the experiments of Tyndall and Magnus upon the diathermancy of moist air, with a view to reconcile the discrepancies in their results. The general arrangement of the apparatus was similar to that used by Wild, a Leslie's cube being placed on either side of a Melloni's pile furnished with its conical reflectors. But for the introduction of the moist air between the cube and pile on the one side and the dry air on the other, two cylinders were used, the one filled with moistened pumice, the other with calcium chloride. These were placed beneath the line joining the pile with the source of heat, so that, whenever a current of air was driven through them, moist air rose at one end of the pile and dry at the other. With a very delicate galvanometer no deviation could be detected. A pair of tubes, each 25 centimeters long, open at the ends, and bored laterally with fine holes, was then substituted, but with scarcely an appreciable result. Both tubes were now placed on the same side of the pile, and a slight but distinct deviation was observed, amounting to 1.7 per cent. The tube was now increased to a meter in length, a heated copper plate being used as the source of heat. The absorption of moist air was 2 per cent. The experiments were repeated with various sources of heat; the absorption by moist air varied from 3 to 0.4 per cent. Alcohol vapor absorbed, under like conditions, from 6 to 27 per cent. of the heat. Hoorweg con-

cludes with Tyndall that aqueous vapor has an appreciable absorbing power for heat, though it is much less than Tyndall supposed. The controversy between Tyndall and Magnus was a very natural one, Tyndall, on the one hand, having overestimated this absorption through neglecting condensation, or vapor-hesion, as Magnus called it; and Magnus, on the other, having denied its existence because the tube he used was entirely too short to make it apparent with the galvanometer employed in his experiments.

OPTICS.

In Optics, Crookes has published some curious and delicate experiments, in which carefully suspended disks of pith were set in motion in vacuo, apparently by the action of light. In a public lecture, however, given in Edinburgh, Professor Dewar, after explaining the method adopted by Professor Tait and himself for obtaining very perfect vacua by taking advantage of the power that charcoal has of condensing gases, stated that these vacua were so perfect that it was impossible to force through them an electric spark between electrodes one quarter of an inch apart, even when a powerful coil is employed; and hence that such vacua were, therefore, eminently proper to repeat the investigation recently made by Mr. Crookes upon the action of a beam of light on a disk at the end of a delicately suspended glass fibre. Such an investigation has been made by Dewar, and he finds that the movements of the disk are due entirely to radiant heat, and not to any mysterious agency, as Mr. Crookes seems to imply. The sensitiveness of the disk increases with the perfection of the vacuum. The sides of the glass receiver must be quite thin. If the disks are covered with lampblack, they are affected much sooner than if left white. The conductivity of the suspended body for heat, and the nature of the residuum gas within the vacuum, determine the density of the gas corresponding to the neutral point observed by Mr. Crookes. The intensity of the movements of the disk increases in proportion to the inverse square of the distance of the source of radiation. If we interpose between the light and the disk a substance opaque to heat rays, although transparent to light, the movements of the disk immediately cease. If we interpose a substance transparent to heat, but opaque to light, the deflection

of the disk is large. If two disks are taken, one of rock-salt and the other of glass, it is found that the rock-salt is inactive when a beam of light is thrown on it, but the glass disk is active, the reason being that the rock-salt is not heated, whereas the glass is heated. To show the sensitiveness of the apparatus, it may be stated that an ordinary lucifer-match will, at a distance of four feet, produce instant action. Professor Dewar has not accepted the suggestion of Reynolds that the action is due to the evaporation of some of the fluid on the surface of the disk. These phenomena allow of a very perfect explanation, according to the principles of the kinetic theory of gases and the mechanical theory of heat, according to which the particles of gas are flying about in all directions with a velocity which depends upon their temperature; the length of the path of each particle is dependent principally upon the barometric pressure. Under ordinary barometric pressure of thirty inches, the length of the average path is about one ten-thousandth of a millimeter, but when the barometric pressure is reduced to the one-millionth part of an inch, the average length of the path between two collisions is about eighteen inches. If, therefore, Mr. Crookes's disks are in such a vacuum, and heated by radiation on one side warmer than on the other, the particles of gas that impinge on that side of the disk leave it at a higher temperature, and therefore with a greater velocity, than those striking the opposite side. Hence there is a recoil of the disk as observed by him.

Wibel has made additional experiments upon the cause of the luminosity of flames. He finds the results of Knapp confirmed, that nitrogen, hydrogen chloride, carbon dioxide, and other indifferent gases, act like air to destroy the luminosity of gas used in a Bunsen burner; but he also finds, curiously enough, that this luminosity may be wholly or partially restored by heating the tube to redness through which the mixture passes. Hence he concludes, 1st, that the absence of luminosity in a Bunsen flame is not due to dilution of the gas; 2d, that it is due to the cooling effect of the inert gas, since, if this be heated, the luminosity returns; 3d, that the luminosity of a flame depends upon the temperature existing in its interior; and, 4th, that ordinary illuminating materials are such because the rising gases and vapors are sufficiently

heated in the exterior combustion zone to cause their decomposition.

Gariel has described some simple apparatus for explaining by construction the elementary laws and formulas of optics.

Cornu has communicated to the Academy a valuable paper on the velocity of light, in which he gives the results of the new measurements made between the Paris Observatory and the tower of Montlhéry, twenty-three kilometers distant, under the direction of the council of the observatory. As a mean of 504 experiments, he finds the velocity of light *in vacuo* to be 300,400 kilometers, or 186,700 English miles, with a probable error below one thousandth in relative value. This gives for the solar parallax, as found by the equation of light, 8.878″, and by the phenomena of aberration, 8.881″.

The same author has described a new measuring instrument for minute quantities, called a reflection lever, which consists of a beam like a balance beam standing on four points, two on the line where the knife edge is usually placed, the other two at the ends of the beam, all four being accurately in one plane. To the centre of the beam is attached transversely a mirror, by means of which any displacement from the horizontal may be detected and measured by the reflected image of a distant scale. The readings are made with a telescope.

Pickering and Strange have investigated photometrically the amount of light absorbed by the sun's atmosphere. By means of a *porte lumière* carrying a black mirror and lens, an image of the sun 40 centimeters in diameter was thrown on a screen 230 centimeters from the aperture. A circular hole was cut in the screen, and behind this the photometer disk was placed. By moving the mirror any portion of the sun's image could be thrown on the photometer, and its light measured. The results were thus given: The probable error does not exceed one per cent., except close to the edge. The light at the edge is about 0.4 that at the centre. The variations in brightness are nearly those which would be produced by a homogeneous atmosphere whose height is equal to the sun's radius, and its opacity such that only twenty-six per cent. of the light is transmitted. There appears to be a slightly different distribution of the light along the polar from that along the equatorial diameter. If the sun's

atmosphere were removed, the brightness of the sun's disk would be uniform, and 3.83 times that of the centre of the disk at present. Moreover, the total amount of light would be increased 4.64 times.

Curtis has published a method of showing the phenomena of extraordinary reflection. Upon a horizontal circular stage, movable around the axis and adjustable in height, a crystal of Iceland spar well polished is placed. A beam of light falls on the crystal at such an angle that after refraction and reflection within it the beam shall pass from it, making the same angle on the other side of the normal. Five images of the opening through which the beam of light comes will be seen, one formed by reflection at the upper surface, and the other four by double reflection within the crystal.

Williams has made a photometric investigation into the intensity of twilight when the sun is at various distances below the horizon. The percentage of error in the instrument employed was about three. The results of the photometer readings were reduced to the light given by a standard candle as unity, when burning at a distance of one meter from the disk. By a graphical construction of the actual results a curve was obtained, and a table deduced which gives the percentage of light, compared with that at sunset as unity, for any number of minutes after sunset up to 34. At 1 minute it is 0.95; at 10 minutes, 0.290; at 20 minutes, 0.064; at 30 minutes, 0.009; and at 34 minutes it is 0.004.

Crosby, also, in the Massachusetts Institute of Technology, has made some photometric determinations of the light of the sky at different distances from the sun, adjusting the mirror and lens which were employed so that the sun's image would fall on the disk, and then measuring the intensity of the light at regular intervals thereafter. In some cases this method was reversed. The results represented graphically show a logarithmic curve, when the intensities are taken as ordinates and the natural sines of the sun's angular distance as abscissæ. The author calls attention to the meteorological importance of his results.

Giraud-Teulon has discovered a new method of measuring distances optically, and has constructed a telemeter based upon it. A double image of the object is produced by a division of the eye-piece, one half moving by the other by

means of a micrometer screw. The apparent size of the object is measured from two stations on the same line with this object, and by a simple calculation, knowing the distance between these stations and the focal length of the telescope, the distance of the object is obtained. The error in the measurements made does not exceed five per cent.

Jacques has determined, in the laboratory of the Massachusetts Institute of Technology, the percentage of light transmitted through glass plates placed both perpendicularly and obliquely to the ray. The plates were ordinary window-glass carefully cleaned. The original light being 100, one plate transmitted 89.5 per cent., four plates 69.3 per cent., seven plates 55 per cent., and ten plates 45.3 per cent. When the plates are oblique to the ray, the amount transmitted by one plate decreases rapidly with the obliquity, while with ten plates it actually increases until the obliquity reaches 55°.

Cornu has proposed a very simple mode of correcting telescopic object-glasses for photographic rays, by separating more or less from each other the lenses composing them, an idea originally suggested by Sir John Herschel for restoring overcorrected objectives. Since the focal distance for chemical rays is about one-half per cent. of the principal focal distance behind that for luminous rays, the necessary correction is effected by separating the flint and crown components by this amount, and then carefully adjusting. Cornu has used the method with success on an object-glass of four inches' aperture; the method of Rutherford is, however, to be preferred for glasses much larger than this.

Pickering and Williams have investigated the foci of lenses placed obliquely, from which it appears that even the most carefully corrected lenses may still be defective in this respect. In a photographic camera, for lines passing through the axis, the surface, instead of being plane, should have a radius of curvature of only 0.3 the focus, while for lines perpendicular to these the curvature should be 0.7 the focus. Curiously enough, the actual curvature in the normal eye is about 0.5, or the mean of the above numbers.

Krüss has described a new eye-piece formed of a divergent flint lens, placed between two convergent lenses of crown, so that the faces in contact have the same radius of curvature,

and consequently touch at all points. Of the four radii of curvature present, the first is +5.27 lines, the second +10 lines, the third +2.9 lines, and the fourth —5.73 lines. The sign plus refers to curves having the convexity toward the eye of the observer. This eye-piece has been constructed by Steinheil, and is sensibly aplanatic and achromatic, with a field of about thirty degrees.

Merz has described a new telescope which he has just completed for the observatory at Quito. It has a clear aperture of 9 Paris inches, and a focal distance of 116.75 inches. The position circle is divided directly to five minutes, and reads with a vernier to one minute. A double-ring micrometer and a filar micrometer are attached, the latter having eight eye-pieces, magnifying respectively 105, 160, 245, 350, 455, 585, 780, and 910 diameters. The hour circle is 18 inches in diameter, and the declination circle 20 inches; the former is divided to one minute, and reads to two seconds of time; the latter is divided to five minutes, and reads to four seconds. A number of improvements in the mounting are noticed.

Rayet has published a paper on the conical solar dials of the ancients, particularly that of Heracleus of Latmos, with a view to bring to light the amount of knowledge possessed by their constructors. The interior surface of these dials constituted a cone, the section of which by the upper horizontal surface was a curve of the second degree, either an ellipse (as in the dial of Heracleus and the Naples dial), a hyperbola (dial at Athens), or a parabola (Phœnician dial). The latter curve requires that one of the generatrices of the cone should be rigorously horizontal, and has been only once observed. But the dials were not made in this way: the cone was traced with any convenient proportions, subject only to the condition that its summit should be on a perpendicular from the centre of the base.

Professor Mayer has called attention to a curious bit of history in relation to Young's theory of colors. It appears that Young first adopted red, yellow, and blue as the primary colors, and that subsequently, taking it for granted that Wollaston was correct when he asserted four natural divisions of color in the solar spectrum, separated from each other by dark lines, he adopted red, green, and violet, these being

the divisions noted by Wollaston. Moreover, Young seems never to have made any experiments to test his theory until some time after he had, on theoretical grounds, adopted it.

Bunsen has given an account of some new methods in spectrum analysis, in which he has sought to render the use of the spark for obtaining spectra as easy and as general as that of the gas-flame. The first portion of his paper is devoted to a description of the battery coil and spark apparatus required; the second gives the results of his investigations in this way, particularly with the rarer elements. The memoir is accompanied by three spectrum plates, uncolored, showing the spectra of thirty elements and compounds.

Watts has described a new form of micrometer for use with the spectroscope, in which one of the lines of the spectrum itself is substituted for the cross wires. This line may be the sodium line, which is almost always present in gas-flame spectra, a hydrogen line with vacua tubes, or a Fraunhofer line in solar work. This standard line is displaced by a micrometer screw, by which the amount of motion necessary to move it from one point of a spectrum to another may be ascertained. The micrometer screw is attached to the upper half of a divided line placed between the prism and the observing telescope, and moves this half over the lower, which is fixed.

Lockyer and Roberts have investigated the absorption spectra of metals volatilized by the oxyhydrogen flame. They employed a block of lime, in which the metal to be examined was placed, and in which it was volatilized by the oxyhydrogen jet. Through a tube cut in the block the beam of electric light passed, which was viewed by the spectroscope placed opposite. In this way the absorption produced by the metallic vapor could be observed. They conclude that in passing from the liquid state to that of perfect gas the molecules pass through different orders of complexity, this complexity being diminished by the action of heat, so that each molecular simplification is marked by a distinctive spectrum.

Goldstein has made some investigations upon the spectra of rarefied gases, which seem to contradict the views of Wüllner. But the latter physicist, in replying to the statements of Goldstein, claims that his view, that a line spec-

trum is the result of the ignition of a single line of molecules, and that a band spectrum appears when the light comes from a thick layer of the gas, is not only not disproved, but is actually confirmed by the new experiments.

Lockyer has read a paper before the Royal Society upon his new map of the solar spectrum, the portion now presented being that extending from wave-lengths 39 to 41. It is constructed on four times the scale of Angström's "Spectre Normale," the number of lines being increased—over this, which contains but 39—to 518, of which 416 have been actually identified, and the largest number of these, 163, assigned to cerium.

Wright has experimented to obtain the spectrum of the gaseous matter evolved from meteorites when heated in a vacuum. The meteorites employed were three in number—those from Texas, from Tazewell County, Tennessee, and from Arva, Hungary. Borings from each of these were placed in a hard glass tube connected with an efficient Sprengel pump. By means of a T tube an ordinary Plücker vacuum tube was also connected with the tube to be heated. At a red heat the Texas iron gave off 4.75 times, the Tennessee iron 4.69 times, and the Hungary iron more than 44 times its volume of gases, which the spectroscope showed to consist of hydrogen, carbonous and carbonic oxides.

The same physicist has published a preliminary note on the spectroscopic examination of gases from a stony meteorite which fell in Iowa on February 12. The small grains of iron which it contained yielded several times their volume of gas, even on raising the temperature but slightly. Of this gas the two oxides of carbon constituted forty-nine per cent. (carbonic acid thirty-five, and carbonic oxide fourteen), the remaining fifty-one per cent. being hydrogen. The spectrum exhibited, the gas being under only a few millimeters' pressure, was that of carbon, especially the three brightest bands in the green and blue. This fact is especially significant when we remember that these are precisely the bands observed in cometary spectra, the close connection of meteors and comets being well established.

In a later paper upon the gaseous constituents of this meteorite, he formulates the following conclusions: 1. The stony meteorites are distinguished from the iron ones by

having the oxides of carbon, chiefly the dioxide, as their characteristic gases, instead of hydrogen. 2. The proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. 3. The amount of the gases contained in a large meteorite, or a cluster of such bodies serving as a cometary nucleus, is sufficient to form the train as ordinarily observed. 4. The spectrum of the gases is closely identical with that of several of the comets.

Montigny has discovered, by means of an ingenious apparatus which he calls a scintillometer, a connection between the variations of color of scintillating stars and their spectra. In every case those stars which scintillate or twinkle least are those whose spectra show numerous well-pronounced lines, sometimes united in zones.

Capron has examined with a spectroscope especially constructed for the purpose the spectrum of the aurora, and has compared it with that of hydrogen, oxygen, oxides of carbon, coal gas, air, hydrogen phosphide, iron, and mercury under various conditions. He differs from Angström in his conclusions, first, as to the presence of moisture in the auroral regions, and, second, as to the importance of the violet pole spectrum in air.

Huggins has sent to the Royal Society a note on the spectrum of Coggia's comet, which presented in the spectroscope three distinct spectra: (1) a continuous spectrum coming from the light of the nucleus; (2) a spectrum consisting of bright bands; and (3) a continuous spectrum accompanying the gaseous spectrum on the coma, and representing almost entirely the light of the tail.

Lubarsch has published a paper on fluorescence, in which he concludes from his investigations (1) that for each fluorescent substance there are only certain rays of light causing fluorescence; (2) that the color of the fluorescent light depends on the rays of incidence, and follows Stokes's law; and (3) that the most refrangible fluorescent rays produced by sunlight correspond to that place in the spectrum where the liquid shows its maximum of absorption, provided its fluorescence proves a simple one when examined by prismatic analysis of the linear spectrum.

Mascart has made some very delicate experiments on the

effect of the translatory motion of the earth on the refrangibility of light, in continuation of those made by Arago, and with reference to Fresnel's theory. His apparatus was arranged underground, so as to be free from diurnal thermal changes. The collimator was turned to the west, so that at mid-day and at midnight the rays entering it would be moving, the one with the earth in direction, the other opposed to it. A very numerous series of observations showed that the change of deviation thus produced is entirely inappreciable, and this with a perfection of methods which would detect a twentieth part of that which Fresnel's formula supposes. Indeed, in using mixed films, for example, Mascart shows that the length of the apparent paths of the interfering rays is not changed by this condition by one two-hundred-thousandth part, that in observing Newton's rings it is not one four-hundred-thousandth, and that in the fringes produced by double refraction there is not produced by the movement of the earth a change in the path of the two rays of one-millionth part.

One of the most valuable optical discoveries of the year is that made by Wolcott Gibbs, of a new physical constant, which he calls the "interferential constant." It is well known that when interference colors are viewed through a prism a series of dark bands appears in the spectrum, known as Talbot's bands. The number of these bands between any two lines in the spectrum may be calculated when we know the thickness of the plate producing the interference, the indices of the given spectrum lines, and their wave-lengths. If now the thickness of the plate be made unity, and the formula thus modified be divided by the density of the substance composing the plate, an expression will be obtained of a quantity called an "interferential constant." It represents the number of bands in the spectrum between two rays whose indices are given, for a thickness of the plate equal to a unit of density. This number is for each chemical substance a characteristic optical function, and independent of the temperature. Its value will apparently be fully equal to the other physical methods of analysis, such as density, boiling point, specific volume, rotatory power, etc., while in some examples given it finds important application in quantitative analysis. Moreover, it appears that the interferential con-

stant of a compound may be tolerably well calculated from those of its constituents.

Descloizeaux has published an elaborate paper on the doubly refractive properties of the triclinic feldspars—albite, oligoclase, labradorite, and anorthite; in which he shows that, though so difficult of exact determination by present physical or chemical means, these feldspars may very readily be distinguished from each other by their optical characters.

Nodot proposes to use either sugar, potassium bichromate, or tartaric-acid crystals in place of aragonite for exhibiting the phenomena of conical refraction. The two former crystals are cut without difficulty, since a natural face of the first and a cleavage face of the second are normal to one of the optic axes. But with tartaric acid it is necessary to get such a face by trial. One is compensated for the labor, however, by the result, a cone being obtained which, for the same thickness of plate, has twice the angle of aragonite.

Mach has devised a new and convenient optical apparatus for certain polarization phenomena. Above the Nicol eyepiece of an ordinary polariscope is placed a small achromatic prism. The field of view will appear, of course, uncolored, but displaced toward the base of the prism. If now the whole eye-piece thus arranged be made to rotate about a vertical axis, each point of the field becomes a circle. If now in the field a quartz plate be placed, cut perpendicular to the axis, and which is covered with a screen having a small hole in it, a circle of colored light will be seen by persistence of vision, the order of colors being in the direction of rotation or the reverse as the quartz is right or left handed. The same apparatus may be used to project the phenomena on a screen. If an unachromatized prism be used, the spectra of the polarization colors are obtained.

Adams has devised a new polariscope for examining the rings of crystals, the objects had in view being (1) to obtain a large field, (2) to secure the means of measuring both the rings and the axial angles, and (3) to be able to immerse the crystal in liquid. The peculiarity of the optical arrangement is that the crystal section is placed at the common centre of curvature of two nearly hemispherical lenses, so that its relation to these is unchanged when the crystal and lenses are rotated about any axis parallel to its surfaces and passing through this centre.

Spottiswoode has constructed a modified form of polariscope, which has some decided advantages. It consists of a Nicol's prism as the polarizer, and a double-image prism as the analyzer, the latter being so cut as to show one image in the centre of the field, the other being excentric. By rapidly rotating the analyzer, the ring image remains by persistence and displays the phenomena, usually successive, simultaneously.

Becquerel, in a research upon magnetic rotatory polarization, has extended the list of substances possessing this property, and has determined exactly the power of rotation for a given thickness of plate and a given magnetic intensity. In general, he finds that increase of magnetic rotatory power follows increase of the refractory index.

Bertin has given a notice on projecting polarization phenomena with the apparatus of Duboscq, dividing these phenomena into three classes—those requiring (1) parallel, (2) divergent, or (3) convergent light.

Riche and Bardy have reported upon the sources of illumination utilizable in photography, in which they give the results of their examination of eight different sources of light, viz., the oxyhydrogen light, the Drummond or lime light, zinc burning in oxygen, magnesium in air, a current of nitric-oxide gas burning in a globe of carbon-disulphide vapor, a jet of nitric oxide in a test-tube containing carbon-disulphide, a jet of oxygen in the same, and a jet of oxygen in a test-tube containing sulphur. The eight lights were photographically intense in the order above mentioned, the last being eight times as strong as the first.

Vogel has proposed a simple form of camera for spectrum photography, which consists simply of a box, in one side of which is fixed, by means of a cork, a pocket spectroscope. With this instrument a picture of the solar spectrum from H to D was taken on silver bromide mixed with naphthalin-red in three minutes.

MAGNETISM.

In Magnetism, Rowland has described a simple method of determining the distribution of magnetism on iron and steel bars by means of a small coil of wire one quarter to one half an inch in diameter, containing from ten to fifty

turns, which he calls a magnetic proof plane. The coil being attached to a galvanometer, it is to be placed on the required spot, and when the needle is at rest it is to be suddenly removed to a distance; the momentary deflection of the galvanometer needle will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil.

Thalen, the Swedish physicist, has written a paper on some experiments which he has made in order to ascertain the location, depth, and magnitude of mines of iron by means of magnetic measurements. By means of careful observations, isodynamic lines are constructed. Then the line which joins the two points of maximum and minimum deviation, or the magnetic meridian of the mine, gives the general direction of the ore bed. The intersection of this line with the neutral line indicates the point where it is most desirable to begin mining. Finally, the distance of this latter point from the point on the magnetic meridian of the mine where the deviation is a minimum is one half the distance of the centre of the mass of ore below the soil.

Beetz has succeeded in producing magnets by electrolysis, the iron having in one case a magnetic moment per gramme of 59, and in another of 214.

Herwig has observed that the extra-induced currents in iron wires are of remarkable intensity, and supposes it to be due to the transversal demagnetization of the iron.

Jacques, working in Professor Pickering's laboratory, has made some experiments in answer to Jamin's criticism of Ampère's theory of magnets, in which he shows not only that Jamin's experiments are not themselves fairly capable of such an interpretation, but also that, rightly interpreted, they actually sustain the theory of Ampère.

Tommasi states the curious fact that if a current of steam, under a pressure of five or six atmospheres, be blown through a copper tube two or three millimeters in diameter coiled in a helix about an iron bar, the bar becomes a magnet, and remains magnetized so long as the steam passes.

Rowland proposes the use of a very small electro-magnet placed upon the stage of the vertical lantern for showing diamagnetic experiments, and shows by theory that there is no advantage gained by the use of a larger apparatus.

ELECTRICITY.

Edlund has published a complete paper on the nature of electricity, in which he maintains with great ability the theory that electricity is identical with the luminiferous ether, and in which he deduces most, if not all, electrical phenomena from this supposition.

Mixter has called attention to the remarkable increase in length of the spark of the Holtz machine by placing a minute gas jet between the balls affording the sparks. In this way the spark, which before was less than ten inches, became more than twelve, a brass ball having only a trifling influence of the same sort.

Rosetti has investigated the action of the Holtz machine, and finds that it follows the law of Ohm completely, but that the electro-motive force and the resistance are enormous. In his instrument the electro-motive force was 57,000 volts when the atmospheric moisture was 0.35, and the resistance, with two turns per second, 2,680,000,000 ohms. From his experiments he deduced 428 as the mechanical equivalent of heat.

Mr. W. Whitehorn has communicated to the Physical Society of London some experiments on the electric conductivity of glass. He shows that, although a perfect non-conductor at ordinary temperatures, yet glass, when heated to redness, allows the electric current to pass freely. Even at the temperature of boiling water a slight amount of electricity is conveyed by it. The resistance at a temperature of 165° C. is nearly forty times that observed at a temperature of 300°. The glass used by Mr. Whitehorn contained oxides of lead, thereby making it a better insulator than other kinds of glass.

Lesueur recommends strongly the use of zinc to prevent the formation of incrustations in steam-boilers. His attention was called to the subject by observing that the brass stays of a surface condenser in a steam-vessel were reduced, after a few years of service, to a mass of spongy copper, the zinc having entirely disappeared. This having occurred repeatedly, the constructors of these condensers placed zinc in the condensers, and observed that not only was the brass no longer attacked, but the boilers supplied from these condensers were entirely free from incrustation. Direct exper-

iments of the author's have confirmed this fact. The explanation of it he finds either in the electric current thus generated in the boiler, the zinc being positive and the iron negative, or more probably in the hydrogen continually set free in minute quantity on the iron surface, thus preventing the adherence of scale. (The author does not seem to be aware that this same device is not new, having been employed for this purpose for many years in the United States.)

Ducretet has noticed a remarkable property of aluminum when conveying a current. If in a voltameter one of the electrodes be aluminum, the other being of platinum, the former being negative, water is decomposed; hydrogen is set free at the aluminum surface, and oxygen at the platinum, the current passing freely. But if the aluminum electrode be made positive, no action takes place, and no current, or a very feeble one, passes. In the first case an electric bell in the circuit rings violently, in the second not at all. It is proposed to call a voltameter thus constructed a rheotome. It is doubtless capable of many useful applications.

Wilson has communicated a paper to the London Physical Society on a method of measuring electrical resistance in liquids, in which polarization of the electrodes is entirely avoided. A long, narrow trough is filled with the liquid to be measured, and a porous cell filled with sulphate of zinc solution is placed at one end, and a similar one containing copper sulphate at the other. In the first of these cells a plate of zinc is placed, and in the second one of copper. The external circuit is completed through a resistance coil and galvanometer. A suitable deflection is obtained at the start, and then one of the porous cells is moved toward the other. The deflection is of course increased, and resistance is introduced to bring it back to that originally obtained. This introduced resistance is evidently equal to that of the column of liquid taken out of the circuit.

Foster has given graphical solutions of a number of simple electrical problems. He prefers the method in which the ordinates represent electro-motive forces and the abscissas resistances, and has devised a simple instrument which he calls a galvanometric sliding-rule, by means of which many problems of this sort may be rapidly and accurately solved.

Amory has published a brief note on the great facility with

which the horizontal pendulum of Zöllner can be used to demonstrate Ampère's laws of the attraction and repulsion of currents.

Barker has described a new and convenient form of lecture galvanometer based on the vertical lantern. Above the horizontal condensing lens of this lantern is the upper needle, suspended by a filament of silk. To this a second needle is attached by means of an aluminum wire passing through the condenser and the mirror. The second needle swings in a coil placed beneath the inclined mirror. Any current in this coil deflects the lower needle, and, of course, the upper one also. This latter only appears on the screen, together with the graduated scale beneath it.

Daguenet has proposed a simple apparatus for showing the phenomena of the spark in rarefied air. A barometer tube a meter in length has a wire of platinum sealed in at one end, and is then filled and inverted in the usual way. On connecting one electrode of an induction coil with the platinum wire and the other with the mercury, the space above the column is filled with a whitish light. By introducing air and plunging the tube in a deep cistern the spark may be observed at various pressures, and by introducing various other gases and liquids many beautiful effects may be produced.

Spottiswoode has presented to the Royal Society a memoir giving the results of his experiments on stratification in electrical discharges through rarefied gases. The experiments were undertaken to ascertain whether the stratification obtained with the continuous discharge of large batteries could not be obtained by a less expensive arrangement in an interrupted circuit. The various means adopted are given, and the peculiarities of the discharge are described. Phenomena analogous to those obtained with the coil were obtained with the Holtz machine.

Becquerel has studied the action of magnetism on the induction spark, and shows that the loud sound which is produced when the current which flows around a powerful electro-magnet is suddenly broken between the poles is due solely to the mechanical action of the magnet, the same effect being produced by a strong blast of air directed on the spark at the instant of breaking circuit.

Schrötter has proved that when the spark passes through a Geissler tube containing phosphorus vapor, the walls of the tube are covered with a thin layer of amorphous phosphorus. Moreover, if the vapor is contained between two sealed tubes, and the spark passes through the interior one, the same effect results, showing that it is due to induction.

Terquem and Trannin have described a new and convenient form of apparatus for piercing glass by the electric spark.

Pickering and Strange have given the results of their measurements on one of Farmer's large dynamo-electric machines. With a speed of 1280 revolutions per minute, a light of from 650 to 900 candle-powers was obtained.

A large Gramme magneto-electric machine was received from Paris in February by the University of Pennsylvania, at Philadelphia, which gives very remarkable results when used for producing the electric light.

Champion, Pellet, and Grenier have published a memoir upon the applications of electricity to the firing of blasts, of torpedoes, and to mining purposes generally, in which are considered the recent improvements in electromotors, in primers, and in fuses, with the various methods of using them to the best effect.

CHEMISTRY.

General Chemistry.—Some advance has been made in chemical theory. Michaelis and Wagner have shown that while two bodies having the empirical constitution of ethyl sulphite are known, yet only one of these is the true sulphurous ether, as proved by its mode of preparation. In this latter compound the ethyl groups are both united to the thionyl by oxygen, and hence the sulphur in the radical must be a tetrad. Zimmermann has made a similar research on ethyl phosphite, and comes to the conclusion that phosphorous acid is a trihydroxyl derivative of phosphorus, and that in the ether neither of the ethyl groups is directly united to the phosphorus, since in that case ethyl-phosphinic acid would appear as a decomposition product. From this theoretical position the author proceeded to prepare tri-sodium phosphite, which he obtained only as a thick sirup, but in which the ratio of the phosphorus and the sodium could be determined.

Friedel has produced a direct union of methyl oxide and hydrogen chloride—a body which, since both of its constituents can exist free, must be classed with the molecular compounds of Kekulé. But Friedel shows that this body is not decomposed when converted into vapor, and hence argues that the ordinary rules of chemical union should be extended to it. This can only be done by supposing its oxygen to act as a tetrad or its chlorine as a triad. Since hydrogen chloride and methyl chloride do not unite even at $-18°$ to $-20°$, the author inclines to the former view, and supports it by other cases, such as water of crystallization—a view of the matter which was taken some years ago by Wolcott Gibbs.

Hübner has shown that benzoic acid will set nitrobenzoic acid free from its salts. As the latter is the stronger acid, the fact is an important one in chemical dynamics.

Meyer and Lecco have sought to fix the equivalence of nitrogen in ammonium compounds by an examination of the chloride of di-ethyl-di-methyl-ammonium, derived (*a*) from di-ethyl-amine, and (*b*) from di-methyl-amine. If the same chloride is formed by these two processes, then ammonium is a derivative of quinquivalent nitrogen; if two isomeric chlorides result, then nitrogen is a triad in ammonium compounds. The most minute examination failed to show any difference in the bodies obtained, and hence confirms the variability of nitrogen equivalence. They afterward proved that in the higher substituted ammonias no exchange of radicals takes place within the molecule; thus answering Lossen's objection to the results they had previously obtained, which proved that ammonium chloride and its substitution derivatives were atomic and not molecular compounds, and that hence the nitrogen in them was quinquivalent.

INORGANIC CHEMISTRY.

In Inorganic Chemistry Pebal has examined euchlorine and hypochloric acid critically, and comes to the conclusion that the former is a mixture of the latter and free chlorine in variable proportions. He assigns to the latter the formula ClO_2.

Göpner claims to have shown that the so-called hydrate of chlorine is really a hydrate of a molecular union of hydrochloric and hypochlorous acids. He bases his opinion on the

fact observed by him that when this hydrate acts on mercury, mercuric and not mercurous chloride results. To this view Schiff decidedly objects, both on grounds of antecedent improbability and of experimental evidence.

Kingzett has succeeded in crystallizing a hydrate of calcium hypochlorite from a saturated solution of bleaching-powder.

Reyman has detected bromoform in commercial bromine, and says it may easily be recognized by its odor, and by the fact that it lessens the solubility of the bromine in water.

Buchanan, chemist to the *Challenger* expedition, finds that sea-water, artificially cooled, crystallizes in hexagonal tables, the water from the melting of which yields 1.578 grammes of chlorine to the liter. Iceberg ice, on the contrary, gave only 0.052 to 0.1723 gramme in a liter.

Deering has noted some points worthy of notice in examining waters by the ammonia method. He observes that the tint after the addition of the Nessler solution increases constantly in depth; hence he makes a caramel solution after ten minutes to imitate the distillate, and uses that for comparison. He also notes that distilled water contains ammonia; that potable waters yield ammonia in the second, third, and fourth fractions; that commercial stick potash gives ammonia when distilled with water; and that an aqueous extract of peat gives much ammonia when distilled with sodium carbonate.

Schöne has proved the presence of hydrogen peroxide in rain and snow water collected in the vicinity of Moscow. Only four out of one hundred and thirty specimens of rain, and twelve out of twenty-nine of snow, failed to give the reaction. Quantitatively the amount in rain varies from 0.04 to one milligramme per liter. The daily maximum was reached between 12 and 4 o'clock P.M., and the annual in August. The peroxide is supposed to exist in the air both free and in solution, and in the amount of 0.000000268 c. c. in a liter.

Scheurer-Kestner has observed that the white fumes accompanying the sulphurous oxide which is produced by the combustion of iron pyrite are caused by the presence of sulphuric oxide, and that the sulphuric oxide is produced by

the oxidation of the sulphurous oxide by air in presence of ferric oxide at a high temperature.

Nichols, under the direction of the State Board of Health of Massachusetts, has examined the composition of the air at different depths below the surface of the "Back Bay lands" in Boston. In three experiments, the depths being three and a half, two, and ten feet respectively, no hydrogen sulphide was detected, ammonia was found in minute quantity, and carbonic-dioxide gas existed in proportions varying from one and a half to twenty-one parts per thousand of air. This amount was approximately proportional to the depth, and reached a maximum in August and September.

The subject of nitrification in soils has been studied by Fittbogen, who has made a series of experiments on the effects of air, with various compounds of potash, lime, magnesia, and of other substances, including quartz sand, on the formation of nitric acid and ammonia in peat. The greatest gain of nitric acid was produced by carbonate of potash; carbonate of lime, caustic lime, and caustic magnesia were next in order of efficiency; with gypsum and sand less nitric acid was formed than when the peat was simply exposed to air, with no admixture. The amount of ammonia in the peat increased under the influence of air alone, but decreased in each case when mineral matters were added to the peat. Fittbogen suggests that the marked power of carbonate of potash to aid the formation of nitric acid from the nitrogen of organic compounds in the soil may explain in part the usefulness of wood ashes as a fertilizer. Their potash would not only act directly as plant food, but would also be especially efficient in furthering the change of the combined nitrogen of the soil into forms more fit for the nourishment of vegetation.

Ditte has proposed a new and simple mode of determining boric acid, which depends upon the crystallization of calcium borate when a salt of boric acid is introduced into a fused mixture of one part calcium chloride and three parts mixed sodium and potassium chlorides. This crystallization takes place upon the surface of the fused chlorides in the form of a ring on the sides of the crucible. Being insoluble in water, the calcium borate is left when the mass is treated with cold water, and may be collected on a filter, dried, and weighed.

Schnetzler has investigated the action of borax upon

fermentation and putrefaction, following out some experiments made by Dumas. He finds that borax acts promptly upon the protoplasm within living vegetable cells, causing it to contract, to separate from the cell walls, and to condense. All movement is at once stopped within the cell, and the chlorophyll grains are changed in form. The cells of yeast, of mould, etc., lose their vitality in a solution of borax. Infusoria, rotifers, entomostracans, tadpoles are killed in such a solution. In the infusoria the contraction of the sarcode can be distinctly seen. Grapes and currants are perfectly preserved by borax; milk containing one grain of borax in thirty cubic centimeters remained sweet for three months; and beef was preserved for a year and a half in a concentrated solution, which was renewed three times, without the least odor of decomposition. Borax is, therefore, strongly recommended for the preservation of anatomical preparations and for dressing wounds.

Schutzenberger and Bourgeois have sought to throw some light upon the production in plants of the so-called carbohydrates by an investigation of the products resulting from the solution of white cast iron (in which the carbon is combined) when conducted at ordinary temperatures. They find that the residue obtained on treating 100 grains of this iron with a cold solution of copper sulphate is, after removal of the copper, a brownish-black pulverulent substance weighing 7.135 grains, and consisting of carbon, 64 per cent.; water, 26.10; silica, 7.1; undetermined, 1.8. It appears to be a hydrate of carbon, having three molecules of water united to eleven atoms of carbon. Nitric acid oxidizes it to a reddish-brown amorphous substance, which the authors call nitrographitoic acid.

Delachanal and Mermet have proposed a method for determining the amount of carbon disulphide contained in the alkali sulphocarbonates of commerce which are now coming into quite general use for the destruction of the phylloxera. The solution is precipitated with acetate of lead, the lead sulphocarbonate decomposed into lead sulphide and carbon disulphide by heat, the latter being carried over into sulphuric acid to retain the accompanying vapor of water, and then into a tared portion of olive-oil, where it is retained.

Heumann, in a paper upon the cause of the luminosity of

flames, gives experimental evidence to prove (A) that a flame may be rendered non-luminous (*a*) by cooling it, (*b*) by diluting it with an indifferent gas, the temperature of combustion not being increased thereby, and (*c*) by energetic oxidation of the luminous matter; and (B) that the luminosity may be restored (*a*) by heating the flame, (*b*) by raising the temperature of its combustion, as by heating the gases before they burn, and (*c*) by diluting the oxygen with an indifferent gas. In a subsequent paper he asserts, contrary to the view expressed by Blochmann, that it is to the cooling of the gas by the burner itself, or by some object introduced into it, that the space between the flame and the burner or the object is due.

Laspeyres has proposed a more perfect apparatus for the direct estimation of water in minerals, etc., consisting of a series of calcium-chloride tubes, through which a current of dry air is passed, in which the substance is heated. The chloride of calcium used is dried at 150° to 200° C.

Vierordt has suggested the use of his quantitative spectrum-analysis method in volumetric assay, and gives experiments which show its very great advantages.

Volhard has aided analytical processes by describing a new swimmer for burettes, a new form of ammonia apparatus, and a new calcium-chloride tube for organic analysis.

Bach has described some simple devices for laboratory apparatus, viz., a water-blast, a wash-bottle with constant stream, and a gas cock.

Griffin describes his new form of portable gas furnace, in which a pound of cast iron can be melted in thirty-five minutes, and the new method of supporting crucibles in it.

Godeffroy has discovered that cæsium salts give precipitates readily with quite a number of metallic chlorides, thus making the reaction with antimonous chloride previously observed by him quite general. The reaction he has observed with chlorides of the following metals, all the precipitates being crystalline: iron, bismuth, zinc, cadmium, mercury, copper, manganese, and nickel. Rubidium salts behave similarly.

Nilson has made a series of experiments on the salts (particularly the selenites) of the rarer earths, with a view to determine the equivalents of the contained elements. He

concludes that glucinum has an equivalence of two, and belongs to the magnesium group, while yttrium, erbium, cerium, lanthanum, and didymium have an equivalence of four, like aluminum, iron, chromium, and indium, their double atoms, also, like the latter, having an equivalence of six.

Santesson has examined a series of niobium compounds, and has minutely described the principal fluoniobates.

Hammerbacher has succeeded in discovering the presence of thallium in carnallite, though the quantity was too small to enable him to isolate it. Rubidium and cæsium were also detected by the spectroscope in this and in sylvite.

Hawes has made a chemical investigation of the trap-rocks of the Connecticut Valley. The results show that the ejected rock had originally the same composition, and hence, presumably, that wherever now found, it came in the first place from the same source, and that a deep-seated one. Subsequent action has converted the dolerite into a diabase, the principal action being upon the pyroxene, which was converted into chlorite. The chief minerals composing the dolerite are pyroxene and labradorite—sometimes anorthite—with a little chrysolite and apatite. Magnetite is also found in these traps, in some of them to the amount of nearly fourteen per cent.

Terreil has proposed a new method of producing pure nickel salts on a commercial scale without the employment of either hydrogen sulphide or ammonia. His process consists of four operations: first, solution of the nickel in acid; second, precipitation of the copper by iron; third, peroxidation of the iron, and transformation of the metals into sulphates; and, fourth, precipitation of the iron by barium carbonate and crystallization of the pure nickel sulphate.

Treve and Durassier have experimented to ascertain the relation which exists between the chemical composition of a steel and its coercitive force. They find that up to a certain limit (from 1 to 1.15 per cent. of carbon) the magnetic saturation increases with the content of carbon. Durassier gives a note of great practical value on the choice of steels for different purposes.

Hartley has given a simple mode of assaying an iron ore when the facilities of a laboratory are wanting. The ore is balanced (on a rude pair of scales without weights) against

pure iron wire, both are dissolved and made up to the same volume, and one fiftieth of each is taken for titrition.

J. L. Smith has discovered, in investigating the anomalous fact that while ferric oxide as ordinarily precipitated and dried is not magnetic, the oxide thrown down from solutions of meteorites is invariably magnetic; that any solution of iron containing nickel, cobalt, or copper gives a precipitate of ferric oxide which becomes magnetic on drying. The exact cause of this action is obscure. Chandler suggests the formation of a saline oxide, analogous to the magnetic oxide of iron, with these metals.

Boussingault has published an elaborate research into the manufacture of steel by cementation, the analytical results of which must prove of great value.

Bauer has examined the action of strong sulphuric acid upon lead and lead alloys. He finds that small quantities of antimony and copper increase the resisting power of lead to this acid, but the bismuth in a lead alloy diminishes it.

Kaemmerer has succeeded in obtaining well-defined crystals of cadmium by distilling the metal in a current of hydrogen. The crystals are isometric, being octohedrons, dodecahedrons, and their derivatives.

Delachanal and Mermet have prepared a compound of platinum, tin, and oxygen analogous to the gold compound known as the purple of Cassius. When the brown liquid which is obtained when a solution of platinic chloride is mixed with one of stannous chloride is diluted with water and boiled, a brown substance is precipitated which, when well washed with hot water, contains no chlorine, but only oxygen, tin, and platinum. The authors have also prepared the same substance by placing a strip of tin in platinic chloride. Its composition somewhat varies with its mode of preparation.

Bibra concludes from his investigations that silver chloride when blackened by the action of light is not subchloride; the true subchloride, obtained by the action of hydrochloric acid on argentous citrate, having the formula Ag_4Cl_3.

ORGANIC CHEMISTRY.

In Organic Chemistry, Carnelley has shown that when the mixed vapors of carbon disulphide and alcohol are passed

over red-hot copper, carbonyl sulphide, ethyl hydride, and copper sulphide are the normal products; but that the ethyl hydride breaks up into marsh gas, ethylene, acetylene, and ethyl aldehyde.

Gladstone and Tribe have continued their researches upon the action of their copper-zinc couple on organic bodies, and have studied its action on chloroform, bromoform, and iodoform. In presence of alcohol the three bodies are split up in the same general manner, acetylene and marsh gas being, in addition to the haloid zinc ethylates, the hydrocarbon products. The amount of acetylene is least with chloroform, greatest with iodoform.

Berthelot has contrived an interesting lecture experiment for showing the direct union of the olefines with the hydracids. Two flasks of about three hundred cubic centimeters' capacity are previously filled, the one with propylene gas, the other with hydrogen-iodide gas. In the lecture these flasks are opened and placed mouth to mouth, the joint between them being made tight by a band of rubber. Drops of isopropyl iodide soon appear, and the combination is complete in half an hour.

Riban has published an extended memoir on the terebenic hydrocarbons and their isomers which is of great value. He differs from Berthelot in many of his conclusions.

Bouchardat, by heating isoprene in a sealed tube to 280°–290° for ten hours, has succeeded in polymerizing it, and converting it into a terpilene closely identical with oil of turpentine.

Tilden has produced a new body by the action of nitrosyl chloride upon oil of turpentine, which he calls nitrosoterpene.

Frebault has observed that a peculiar green coloration is developed in oil of peppermint by the action of certain acids, notably picric acid, which has a red fluorescence similar to chlorophyll. He suggests, therefore, that this substance is formed in the reaction.

Barbier has investigated the hydrocarbon discovered by Berthelot, and called fluorene. By oxidation it yields diphenylene-carbonyl, and this acted on by sodium amalgam produces fluorene alcohol in hard, white, hexagonal plates. This substance is interesting as being the first alcohol which by heat alone loses water and forms an ether.

Ekstrand has prepared the hydrocarbon retene from the heavy oils obtained in the distillation of wood, and has studied its properties. It forms sulpho-conjugated acids, and by oxidation affords dioxyretistene and two other bodies, both monobasic acids.

Armstrong calls attention to some remarkable changes of certain isomers in the aromatic series into each other, effected by changes of temperature; and hence infers that extreme caution should be exercised in judging of the constitution of these bodies.

Meyer and Ambühl have succeeded in producing a compound in the fatty series analogous to azobenzol in the aromatic. When solutions of diazobenzol sulphate and sodium nitro-ethane are mixed, a yellow oily body separates, which after purification crystallizes in square orange-colored plates. It is azo-nitro-ethyl-phenyl.

Gutzeit has succeeded in isolating from the fruits of several plants sufficient ethyl alcohol to prove that this substance, hitherto supposed to be solely a result of fermentation, is a normal constituent of the unfermented juices of plants.

Renard has made some experiments on the action of electrolytic oxygen upon methyl and ethyl alcohols. Using five Bunsen elements, and 100 cubic centimeters of ethyl alcohol acidulated with five per cent. of a dilute sulphuric acid, the action being continued for forty-eight hours, he succeeded in proving the presence in the liquid of methyl formate, aldehyde, ethyl acetate, acetal, and a new body—ethylidene monoethylate. It is acetal in which ethyl is replaced by hydrogen. Sulphethylic acid was also produced in the electrolysis. Methyl alcohol thus treated yielded carbon dioxide and methyl oxide gases, besides methyl formate, methylal, and methyl acetate.

Wagner and Saytzeff have succeeded in synthetically producing a new amyl alcohol. Of the eight isomeric amyl alcohols pointed out by theory, four are primary, three are secondary, and one is tertiary. Of these, again, five were previously known; the new one now discovered is the sixth. It is di-ethyl-carbinol, of course a secondary alcohol, and is produced by the action of zinc-ethyl on ethyl formate, the reaction being foreseen by theory before it was realized as fact.

Freund has examined the asserted production of trimethylcarbinol in ordinary alcoholic fermentation, and has been entirely unable to find a trace of it in the products of distillation.

Berthelot has effected a simple dissociation of aldehyde by heating a mixture of five volumes of hydrogen and two volumes of aldehyde vapor to a red heat for half an hour. The products were carbonous oxide and methane.

Meyer has succeeded in producing acrolein by the imperfect combustion of ethylene. When to 100 volumes of ethylene gas 62 to 65 volumes of oxygen are added and exploded in a eudiometer, carbonous oxide, hydrogen, and condensed hydrocarbon gases are formed, and carbon is separated. At the same time the carbonous oxide unites to the undecomposed ethylene present, and produces acrolein. This was recognized by its well-known properties, and by conversion into acrylic acid.

Von Lang has measured the crystals of glycerin. They are brilliant when in their mother-liquid, but deliquesce in the air. In form they are orthorhombic, the ratio of the axes $a:b:c=1:0.70:0.66$.

Von Zotta has examined more closely the production of glyceric oxide by the action of calcium chloride on glycerin. The product is an oily liquid of specific gravity 1.16, converted into glycerin again on boiling its aqueous solution.

Prevost has given a new and simple method of preparing epichlorhydrin, which consists in warming dichlorhydrin in a capacious retort attached to a receiver, and adding pulverized sodium hydrate to it in the proportion of 250 grammes to 550 cubic centimeters of dichlorhydrin, the temperature being kept below 130°. Almost pure epichlorhydrin distills over.

Clin has given a method for the preparation of crystallized monobromcamphor — being camphor in which an atom of bromine has replaced one of hydrogen—by the direct action, at 100° C., of bromine upon camphor. The specimens shown to the French Academy were magnificently crystallized.

Bourneville finds that monobromcamphor (1) lessens the number of beats of the heart, (2) lessens the number of inspirations, (3) lowers the temperature of the body, (4) possesses powerful sedative properties, and (5) produces ordi-

narily no disturbance of the digestive organs. It has been used with good effect in nervous affections, even in cases of long standing.

Hesse has published a valuable investigation giving the exact data concerning the rotatory power of a large number of organic bodies—including the sugars—on polarized light.

Kreusler has negatived the assertion of Raoult that pure cane sugar in aqueous solution, without the presence of air or ferments, but solely by the action of light, became inverted and yielded glucose. Solutions of various strengths were sealed up *in vacuo*, and were exposed to direct sunlight whenever possible for eleven months. Not a trace of glucose could be detected. In presence of air, however, some glucose is formed; and to this fact the author attributes the results obtained by Raoult.

Gautier has effected an important synthesis likely to prove of practical value. He has succeeded in uniting two molecules of dextrose by abstracting from them a molecule of water, thus forming a substance having the composition of the compound sugars. The result was accomplished by the action of hydrochloric-acid gas on the dextrose dissolved in absolute alcohol. A substance was obtained which was more analogous to gum and dextrin than to sugar in appearance and taste, but which yielded again a simple sugar on heating, though this appeared not to be dextrose again, but to be analogous to, if not identical with, inosite.

Giraud has given an analysis of gum-tragacanth, by which it appears that sixty per cent. of it is a pectic compound apparently identical with the pectose of Fremy, existing in unripe fruits and in turnip roots, etc. Pectic acid and pectin were both prepared from the gum. The other constituents are—water, twenty per cent.; soluble gum, eight to ten per cent.; cellulose, starch, and mineral matters, each three per cent.

Reichardt has prepared from the thoroughly exhausted beet-root pulp a new carbohydrate isomeric with Scheibler's arabinic acid, which he calls pararabin. The pulp consists of 38.5 per cent. arabinic acid, 54 per cent. pararabin, and 7.5 per cent. cellulose.

Hofmann has examined a new red coloring matter, brought into commerce within a few months under the name of eosin.

It has an exceedingly rich tint, recalling that of rosaniline, but inclining more to a garnet red. In mass it is a brown powder with a greenish metallic lustre. Upon investigation it proved to be a bromine-derivative of one of the remarkably fluorescent bodies discovered by Baeyer, and called fluorescein, obtained by the action of phthalic oxide upon resorcin. Its composition proved it to be a phthalein of dibromresorcin, and this was confirmed by its successful synthesis, by the action of bromine on fluorescein.

Benedikt has prepared phlorein by the action of nitrous acid on phloroglucin. It is a beautiful dark-green powder with a metallic lustre, dissolving in caustic and carbonated alkalies with an intense violet color. As it was found to contain nitrogen, its allies, brasilein and hæmatein (coloring matters from Brazil-wood and logwood respectively), were examined, and found also to contain it, having been heretofore overlooked in the analysis.

Liebermann has investigated the coloring matter known as emodin, which accompanies chrysophanic acid in the root of rhubarb. Distilled with zinc dust it yielded a substance closely resembling anthracene. But on treating it with acetyl oxide, a mono- and a tri-acetyl derivative were obtained, and it was shown to be a derivative of methyl-anthracene, the next higher homologue of anthracene. Further examination proved emodin to be trioxymethyl-anthraquinone.

Liebermann and Fischer, on account of the importance of the oxyanthraquinones as coloring matters, have sought to discover a method by which they could be converted the one into the other. From purpurin they prepared purpuramide; and by the action of nitrous acid on this they obtained a bioxyanthraquinone which proved to be identical with the purpuroxanthin of Schützenberger, obtained in quite a different way.

Claus has discovered in the alizarin paste of commerce a peculiar substance which dissolves to a blood-red liquid with alkalies. It crystallizes from acetic acid in large dark-brown needles with a bronze lustre. At 305° to 310° C. it sublimes, and condenses in orange needles. On examination it proved to be the dioxyquinone of chrysene, *i. e.*, the alizarin of chrysene. Hence Claus gives to it the name chrysezarin.

Stenhouse and Groves have shown that, by the prolonged action of chlorine upon pyrogallol, two new bodies are formed, which they call respectively mairogallol and leucogallol. The former is produced by a long-continued action of the gas, and crystallizes from boiling glacial acetic acid, or from mixed ether and glacial acid, in brilliant orthorhombic prisms. Leucogallol forms crystalline crusts composed of minute colorless needles.

Lorin has described a method of preparing concentrated formic acid, which consists in adding to concentrated glycerin, contained in a tubulated retort, and heated to 87°, dehydrated oxalic acid in powder, repeating the process whenever the evolution of gas ceases. The formic acid which distills over is rectified, and then contains ninety-four per cent. of real acid.

Bremer, by the action of phosphorus and iodine upon ordinary tartaric acid (dextrorotatory) in presence of water in a sealed tube, has succeeded in obtaining from it a new malic acid, which also rotates to the right. He is now experimenting upon lævorotatory tartaric acid, in the hope of producing a left-handed malic acid, and by the union of the two an inactive acid.

Carey Lea has published a valuable modification of the usual iron test for hydrocyanic acid. If a little uranic acetate be added to a solution of a ferrous salt, there is thrown down in presence of a soluble cyanide a purple precipitate. One five-thousandth of a grain of hydrocyanic acid gives, when thus treated, a perfectly distinct reaction. He also recommends the use of ammonio-ferric citrate, in connection with ferrous salts, in the Prussian-blue test. In this way one two-thousandth of a grain of potassic cyanide may be detected, a delicacy far greater than has been before claimed for this test.

The crude acids of the native petroleum of Wallachia have been examined by Hell and Medinger. The second run of the still yields to caustic soda an acid which, after solution in water and treatment with sulphuric acid, collects as an oil on the surface, and is called "mineral oil" by the workmen. This is a mixture of several acids, probably homologous, but their separation is exceedingly difficult. An ethyl-ether of one was finally obtained, whose saponification yielded the

acid as a colorless liquid of specific gravity 0.982. It is a weak acid, its sodium and potassium salts being of the consistency of soft soap. It is a fatty acid, but does not belong to either of the three series of fatty acids now known.

Berthelot has observed that perfectly pure acetic oxide is not changed into the sodium salt in presence of sodium hydrate, even after the anhydride is completely dissolved. The acetic oxide, therefore, even when dissolved, may exist for some time in contact with water, and even of soda, without union. In presence of an alkali the union is much more rapid, taking place in the course of two or three minutes, whereas in the case of water it requires more than an hour.

Carey Lea publishes some experiments which show that methyl nitrate is not nearly so explosive as has been stated by Girard. It does not explode by percussion, and the explosion is feeble when the liquid is heated. Nevertheless, he thinks a few suggestions desirable on the precautions to be taken in its manufacture on a large scale.

Klippert has prepared ethyl orthosilicate very readily by the action of silicon fluoride upon sodium ethylate.

Pinner has effected a synthesis of malonic acid by boiling ethyl chloracrylate with barium hydrate for a long time. The conversion of the one into the other raises some interesting theoretical questions.

Ramsay has examined the properties of ethyl-thiosulphate of sodium prepared by the action of ethyl bromide on sodium thiosulphate. He finds that it is exceedingly unstable, decomposing spontaneously in a few weeks. The precipitates produced in its solutions by silver, lead, or barium nitrates are even more rapidly decomposed, only a few hours being required. When distilled with phosphoric chloride a complex reaction takes place, ethyl disulphide being one of the products.

Zöllner and Grete have made a series of experiments in the Royal Agricultural School at Vienna upon Dumas's remedy for the phylloxera, that pest of the grape-culture. They find that while his potassium sulphocarbonate will do the work, yet that the ethylsulphocarbonate will do it better, since, while it also evolves the effective carbon disulphide, it does not evolve the deleterious hydrogen sulphide. Moreover, it is more readily made, and is cheaper. They recom-

mend more especially, however, the amylsulphocarbonate of potassium as being cheaper, costing only about fifteen cents per pound.

Kolbe has further investigated the fact, observed by his assistant, Ost, that while sodium silicate yields on dry distillation sodium sodiosalicylate, potassium salicylate similarly treated yields potassium paraoxybenzoate. He finds that the barium, strontium, calcium, and magnesium salts act like the sodium salt, and that the potassium salt does the same when heated only to 145°. He recommends this as the best method for the preparation of paraoxybenzoic acid. A series of papers has been published in Kolbe's *Journal* by Neubauer, Kolbe, Wagner, Fontheim, Zürn, and others upon the antiseptic action of salicylic acid. It has come very extensively into use, having, for example, entirely replaced phenol in the lying-in hospital of Leipsic.

Weiske proposes the use of salicylic acid in titrition, especially in acidimetry. A convenient quantity of it is dissolved in distilled water, and a few drops of ferric chloride solution is added. To the intensely colored solution soda solution is added to exact neutralization, the color changing to yellowish-red. If a few cubic centimeters of this liquid be added to the acid to be titered, the color becomes of a deeper violet as the soda solution is added, reaching its highest intensity just before neutralization, and becoming colorless on the slightest excess of alkali.

Knop has made a series of experiments to ascertain the action of salicylic acid upon vegetation. He finds that it has a marked depression of action upon the vegetative activity of cells, whether these be the chlorophyl cells of the higher or the non-chlorophyl cells of the lower orders of plants, provided only the acid be free. Of fifteen grains of corn soaked in water containing $\frac{1}{1000}$ of this acid, fourteen failed to germinate. Moreover, mould is prevented by a quantity of salicylic acid as minute as this.

Rautert has given an improved method of purifying salicylic acid by distilling it in a current of superheated steam. Recrystallization from water makes it snow-white.

Kolbe has thoroughly investigated the properties of his "salylic acid" obtained by reducing chlorsalylic acid with sodium amalgam, and has come to the conclusion that it is

nothing but benzoic acid to which some foreign fatty substance, formed at the same time, obstinately adheres. When oxidized by potassium permanganate, pure benzoic acid crystallizes from the solution.

Hartmann, following Kolbe's lead in proving that when chlorsalylic (metachlorbenzoic) acid was reduced with sodium amalgam, benzoic acid resulted, has reduced chlordracylic (parachlorbenzoic) acid by the same means, and has also obtained benzoic acid as the reduction product.

Boussingault calls attention to the uncertainty of the guaiacum test for kirsch cordial. He states that the blue color is not characteristic, since it is developed in zwetschen or prune cordial, and does not always appear in genuine kirsch. Upon investigation, he finds that the blue coloration is due to the presence of copper, and asserts that any specimen of kirsch which is blued by guaiacum will give with potassium ferro-cyanide a red precipitate of copper-ferro-cyanide.

Weith has shown that, by the action of ammonium chloride on methyl alcohol, there is produced both tri-methylamine and tetra-methyl-ammonium, the whole of the chloride being thus converted.

Drechsel has succeeded in forming trimethyl-phosphine by heating together phosphonium iodide and carbon disulphide.

Engel has discovered some new reactions of glycocoll. It gives with ferric chloride an intense red color, and it develops a blue coloration when treated with a drop of phenol and sodium hypochlorite is added. The author can not get the blood-red coloration as observed by Horsford when glycocoll is boiled with a solution of potassium or barium hydrate; he hence supposes that Horsford's substance was not pure.

Baumann finds that Hallwachs's amido-dicyanic acid, by heating with sulphuric acid, is converted into biuret.

Engel has given evidence to show that taurin, generally considered to be isethionamide, is really an amic acid. In the first place, it forms salts, that with mercury having been analyzed; and, secondly, treated with cyanamide in excess, it yields a taurin-creatin.

Ponomareff, by the action of persulphocyanogen upon ammonia at 100°, obtained two products: one the thiomelanuric

acid of Jamieson; the other a new body, which he calls thiammelin.

Hesse has given some simple methods of testing the cinchona alkaloids. He distinguishes quinidine from quinine, cinchonine, and cinchonidine by means of the behavior of water and ammonia with their iodhydrates. If to half a gramme of salt to be tested ten cubic centimeters of water be added, the whole warmed to 60° C., and half a gramme of potassium iodide be added, allowed to cool, and after the lapse of an hour filtered; then, if the quinidine be pure, no turbidity results on adding a drop of ammonia. A precipitate under these circumstances proves the presence of one of the other three alkaloids.

Howard has made an examination of the bark known as *Cinchona pelleterana*, in order to prove finally the existence or non-existence of the alkaloid aricine. His results confirm those of other observers, and point strongly to the existence of aricine as a distinct alkaloid.

Gorup Besanez notices the introduction into commerce from Manilla of a brown extract from *Echitas scolaris*, a tree belonging to the Apocynaceæ, as a febrifuge, under the name Ditain. He succeeded in extracting from it a crystallized non-volatile alkaloid. It is offered as a substitute for quinine.

Jobst and Hesse subsequently made an exhaustive investigation of dita bark, which came from the Philippine Islands. From it had been obtained by Gruppe the substance called ditain, which the authors believe to be of uncertain composition. They confined their examination to the bark itself, and obtained from it several bodies, to which they give the names ditamin, echikautschin, echicerin, echitin, echitein, and echiretin.

PHYSIOLOGICAL CHEMISTRY.

In Physiological Chemistry, Boehm has continued his experiments on the respiration of water plants. He finds that much less oxygen is consumed by them than by land plants, and correspondingly much less carbonic acid is evolved. Indeed, he thinks the relation between the two much the same as between gill-breathing and warm-blooded animals. When dead, these water plants undergo a fermentation, attended with the absorption of hydrogen. He has more recently

studied the decomposition which marsh and water plants undergo under water. He finds that the butyric fermentation takes place, that carbon dioxide and marsh gases are evolved, and that the liquid becomes alkaline from the evolution of ammonia. A partial conversion into peat is finally observed.

Bender has analyzed the gas given off by apples when they are exposed to the air in a finely divided state. The experiment was made on gas prepared by heating the apples, cut in small pieces, in a flask filled with water from which the air had been previously expelled by boiling. At 60° gas bubbles appeared, and became rapid at 100°. Four apples yielded about 100 cubic centimeters of gas, composed in the first experiment of 40.20 per cent. of carbonic acid, 0.43 per cent. of oxygen, and 59.37 per cent. of nitrogen. In subsequent trials more care was taken to exclude the air, and the gas collected consisted of 31.07 per cent. of carbonic acid and 68.93 per cent. of nitrogen. The author thinks the carbonic acid the result of a continuous fermentation going on within the mass.

Boettger states that a dilute solution of ammonia, or a moderately concentrated one of potassium or sodium hydrate, facilitates remarkably the germination of seeds, even of coffee, which usually germinates with difficulty. Grains of coffee moistened with such a solution of potash show, even after the lapse of a few hours, a snow-white plumule one to two millimeters long.

Pierce has studied the physiological action of cotarnine as contrasted with that of hydrocotarnine. While half a gramme of the former could be subcutaneously injected into rabbits and kittens without effect, a similar dose of the latter produced rapid and well-marked tremors, passing into severe epileptiform convulsions, sometimes proving fatal.

Gerber has described a new and more accurate method for the analysis of milk, by which he obtains some very satisfactory results.

Gautier, by dissolving fresh blood-fibrin in a solution of sodium chloride and dialyzing, has obtained a solution which coagulates by heat, and exhibits nearly all the properties of albumin.

Schutzenberger has continued his researches upon albumin, and gives now the general conclusion that albumin and

its congeners are combinations of urea or of oxamide with either saturated or non-saturated amic acids belonging to well-known series.

Boussingault has made analyses of gluten biscuit, with comparative analyses of other similar articles of food, with a view of showing its real value when used as food in cases of glycosuria. From his table it appears, for example, that 73 pounds of baker's bread introduces as much starch into the system as 100 pounds of the gluten biscuit, while the latter affords eight times as much albuminates.

Maly has published a paper on the chemical composition and the physiological importance of the peptones.

Epstein and Müller have sought to throw some light on the beneficial effect of phenol on glycosuria by ascertaining whether phenol prevented at all the action of the liver ferment on the glycogen. Their results were negative. Acids suspend the action of this ferment, while alkalies simply lessen it.

Thudichum has published an extended memoir on bilirubin and its compounds, in which he maintains that the transformation claimed by Maly of this substance into urochrome has not yet been effected.

Scolosuboff has determined that the principal localization of arsenic in animals poisoned with this substance is in the nerve tissue. Hence, in all cases of acute poisoning, the brain should especially be examined, since, when the case is a very rapid one, even the liver may not contain a detectable amount of this poison.

TECHNICAL CHEMISTRY.

In Technical Chemistry, Stierlien has given a method for the detection of the artificial coloring matters used in red wines, together with the results of his examination by it. In these wines he finds logwood, Brazil-wood, red poppy, mallow, blueberry, cherry, elderberry, cochineal, litmus, aniline red, and red beet.

Fordos has published an additional paper on the action of liquids, used for food or medicinally, upon the so-called tin lining of utensils which contain lead. He shows that the deleterious results of the use of such vessels are far more general than is supposed.

Müntz and Ramspacher propose to determine tannin in its solutions by filtering these, under pressure if necessary, through a piece of fresh hide. This combines with the tannin, and the filtrate is entirely free from this substance. A section of the skin afterward shows a line in the middle, above which the skin has thus been converted into leather.

Vogel has continued his researches on the effect of coloring matters on the sensitiveness of collodion to the various rays of the spectrum, and now concludes that the action of the coloring matter may be quite different, according to the nature of the silver salt employed. Naphthalin red, used with silver bromide and silver chloride, gives to both an increased sensitiveness to yellow rays; while fuchsin acts very differently, being with silver bromide in complete accordance with its absorption spectrum—which is similar to that of naphthalin red—but giving to silver chloride but little increased delicacy for yellow rays, but much for the violet ones. The same fact he has observed to be true of certain colorless bodies; morphine, for example, increasing the delicacy of silver iodobromide not only for the blue and violet, but also for the green, while silver bromide is completely unaffected by it. Hence, to produce the effect he at first described, three things are necessary: first, the coloring matter must optically absorb the identical color which the collodion is to be made sensitive to; second, it must unite with any free bromine or iodine; and, third, it must not decompose silver nitrate, since in that case it would injure the preparation of the plates. The so-called night-blue, for example, possesses the first and third conditions, but fails on the second. It has no action, therefore, on the sensitiveness of silver salts to light of different colors.

Carey Lea has published a paper upon the influence exerted by color in changing the sensitiveness of substances to light. He finds, for example, that corallin increases the sensitiveness of silver bromide to red rays, only moderately increases it for yellow rays, and does not increase it at all for green rays, contrary to the view of Vogel. He concludes that there is no relation whatever between the color of substances and the color of the ray to whose influence they modify the sensitiveness of silver bromide.

Vogel, however, maintains that while the chloride, bro-

mide, and iodide of silver are sensitive to rays of both high and low refrangibility, this sensitiveness also depends on the bodies which may be mixed with them, those colored bodies which absorb certain colors (and which promote photographic reduction) increasing the sensibility of the silver salt for the absorbed rays. Moreover, certain colorless bodies which promote photographic reduction, and certain others which influence the index of refraction, also modify the color-sensibility.

MINERALOGY.

The mineralogists in this country and abroad have been far from inactive during the past year, as, in fact, is well shown in the long list of new minerals which is appended. Their investigations have covered a considerable part of the known mineral species, and have resulted in adding much to what has already been published about them.

One of the most important of these memoirs is that by Des Cloizeaux on the optical properties of the feldspar family. He is a profound authority on such subjects, so that these investigations, including a ready means for distinguishing the different feldspar species, become of very great value. The same author has given a crystallographic and optical description of the rare species durangite, which was named some years since by Professor Brush. Another important French contribution to the science is a memoir by Daubrée on the recent formation of a number of minerals in the thermal waters at Bourbonne-les-Bains; these include tetrahedrite, bornite, anglesite, etc. These observations are important as bearing upon the paragenesis of minerals in general.

The number of doubtful minerals has been diminished by the chemical and microscopical studies of Mr. G. W. Hawes, who has shown that neither *chlorastrolite* nor *zonochlorite* deserve places as distinct species. A similar service has been performed by Professor Klein, who by a series of crystallographic investigations has shown that the supposed *wiserine* of Kenngott is nothing but a peculiar form of *octahedrite*. Mr. Hawes has also put the very doubtful mineral of Liebe, *diabantachronnyn*, on a proper footing. The mineral in question is important as occurring frequently in some igneous rocks, and is now called *diabantite*. Professor Cooke

has continued his investigations of the vermiculites, alluded to in the last volume of the *Annual Record*, and has described two new varieties, which throw light on the composition of the group.

Other important memoirs have been contributed by Maskelyne in England, Vom Rath, Websky, Von Zepharovich, and others, in Germany; these are to be found in the various journals, but it would be out of place to refer to them here.

A variety of new mineral localities have been opened in this country, which in future may be expected to produce fine specimens. Perhaps the most remarkable discovery is that of the very rare species *samarskite*, in large quantities in North Carolina. Hitherto it has been known only in small imbedded fragments, but now it has been found in large masses: one obtained by Mr. J. Willcox weighed about twenty pounds, and a second thirteen pounds. Another interesting locality is that of Pike's Peak, Colorado, which has recently afforded crystals of smoky quartz, rivaling those of the Alps, and also very beautiful crystals of a bluish-green feldspar (Amazon stone). The chondrodite locality, at Brewster, N. Y., has produced some fine specimens, and the crystals have been shown to be quite unique in the complexity of their forms.

One of the most valuable additions to the list of mineralogical books is the volume by Dr. Genth, on the mineralogy of the State of Pennsylvania. It includes descriptions of the various mineral localities in the state, with the results of extensive chemical work by the author. Another important publication is the continuation of the mineralogy of Russia by Kokscharow, containing the results of much crystallographic research. Still another work is that completing the series of Hessenberg's "Mineralogical Notices," published after the death of the author, whose loss is a great one for the science.

The following is a list of the new minerals recently introduced into the science; those from American localities are mentioned in a little more detail than the others:

Byerite is a new variety of bituminous coal, described by Mallet as occurring in the Middle Park, Colorado. It is remarkable in yielding a large amount of gas and tarry oil.

Chalcophanite is a new mineral from that most interesting and prolific locality, the zinc mines at Stirling, N. J. It occurs in small tabular crystals and crystalline masses, resembling specular iron at first sight. In composition it is a hydrate of zinc and manganese, related to psilomelane. It takes on a brass color on being heated, whence its name. It was described by Dr. G. E. Moore in the July number of the *American Chemist.*

Chlorotile.—A hydrous arseniate of copper, of a pale green color. Found by Frenzel at Schneeberg, Saxony.

Clarite.—A supposed new sulphide of antimony and copper, resembling enargite, from a mine in the Black Forest. Described by Sandberger.

Cossaite.—A mineral near paragonite, from the mines of Borgofranco, Italy. Described by Gastaldi.

Frenzelite.—A selenide of bismuth from Guanajuato, Mexico. It occurs massive, with distinct cleavage; also in minute needle-like crystals. It has a bluish-black color, and metallic lustre. It was first mentioned by Castillo, but since then more completely described by Frenzel.

Garnierite; Nouméite.—Liversidge, in the Journal of the Chemical Society, has given these names to two hydrous silicates of nickel and magnesia found in serpentine at Noumea, in New Caledonia. Both minerals are distinguished by their apple-green color; they are supposed to differ somewhat in composition, as also in physical characters.

Hydrofranklinite.—Another new mineral from the zinc mines in New Jersey. It appears to be, like chalcophanite, a hydrous oxide of zinc and manganese, but occurs in regular octahedrons. It has been announced by Professor Roepper, though not yet fully described.

Hydrocuprite.—Hydrous oxide of copper; occurring in orange-yellow coatings at Cornwall, Pa. Described by Dr. Genth in the "Mineralogy of Pennsylvania" already alluded to.

Indianaite.—A new porcelain clay from Lawrence County, Indiana. Described by Professor Cox at the meeting of the American Association at Detroit, in August.

Koppite.—A mineral closely related to pyrochlore; from the Kaiserstuhlgebirge, Baden.

Melanosiderite.—This is a basic silicate of iron, related to

limonite. It is of a black color, vitreous lustre, and with a conchoidal fracture. It is found at West Chester, Pa., and was described by Professor J. G. Cooke.

Rauite.—A hydrous silicate, perhaps identical with thomsonite. It is from the island of Lamö, near Norway.

Rivotite contains antimonic acid and carbonate of copper, amorphous with yellow color. Described by Ducloux.

Siegburgite.—A new hydrocarbon, containing eighty-five per cent. of carbon. Found at Siegburg, near Bonn.

Wapplerite.—An arseniate of lime, containing water. It crystallizes in the triclinic system; and is allied to pharmacolite. Found by Frenzel at Joachimsthal.

In addition to the above, Scacchi, in a recent memoir on the eruption of Vesuvius in 1872, has described the following new minerals found by him as products of sublimation: Atelite, chlorocalcite, cryptohalite, chloromagnesite, chlorallumite, cupromagnesite, dolerophanite, erythrosiderite, chlorothionite, hydrofluorite, hydrocyanite, proidonite, pseudocotunnite. For their characters, as far as described, reference must be made to the original research.

GEOLOGY.

Much attention has of late been turned to the study of the crystalline rocks in the southern part of the great Appalachian chain, and many important observations have been made. According to Eugene Smith, the state geologist of Alabama, we find to the southeast of the undoubted paleozoic rocks in that state a belt of crystalline limestones, which are overlaid, in apparent conformability, by a series of strata estimated at 15,000 to 20,000 feet, the whole dipping at high angles to the southeast. These consist of greenish-gray hydro-mica schists, the so-called talcose slates or nacreous argillites, inclosing layers of quartz in their upper part, and succeeded by great beds of quartzite, laminated, schistose, and conglomerate, with chloritic and talcose schists and roofing-slates. These, regarded by Professor Smith as the equivalents of the Ocoee group of East Tennessee, are by him considered probably of pre-Cambrian or Eozoic age, and referred to the Huronian.

They are succeeded to the southeast by gneisses, hornblendic rocks, and coarse mica-slates with granitic veins,

considered by Smith as belonging to the White Mountain series, which alternate with belts of Huronian to the eastward. In one locality the schists are associated with a hypersthenic labradorite rock supposed to be Norian. The unaltered paleozoic strata along the western border are described as dipping toward and apparently passing beneath the adjacent crystalline rocks, a phenomenon well known throughout the Appalachian valley, and due to dislocations in the strata.

The extension of this western belt of crystalline rocks into North Carolina is also by Professor Kerr referred to the Huronian, in which he includes all of the rocks in that state described by Emmons as Taconic. There are good reasons for regarding the lower portions of his Taconic system as Eozoic. In his recent geological map of North Carolina, Professor Kerr groups the crystalline rocks of the state under the three heads of Granites, Huronian, and Laurentian. Some portions of the latter area examined by the writer have, however, been by him referred to the Montalban or White Mountain series. Bradley has lately endeavored to show that the whole of these crystalline strata in North Carolina and East Tennessee are the lower paleozoic rocks, including the Cincinnati group, in an altered condition, thus resuscitating the old views of Rogers, combated more than thirty years ago by Emmons, and since by Hunt and others. Bradley offers in support of this view only conjectures based on supposed lithological parallelisms, which, when we consider the great mineralogical and physical differences, and the entire absence of organic remains in the rocks in question, have very little weight. The alteration and the uplifting of these crystalline strata of the Blue Ridge are by Bradley supposed to be post-Carboniferous, which does not agree with the observations of Fontaine and others, whose observations show these crystalline rocks to have formed the southeastern barrier of the paleozoic sea.

Fontaine describes the Blue Ridge in Virginia as having an axis of coarse granitic and syenitic gneiss, referred by him to the Laurentian series, which is seen near Lynchburg and in the Peaks of Otter, where these gneisses are penetrated by intrusive syenites, and is developed in greater

force as we proceed southwestward. Resting unconformably on both sides of this ancient series is a group of schistose rocks which to the northward conceal the Laurentian. This series, which consists in large part of argillites and micaceous and chloritic schists, with epidotic, hornblendic, feldspathic, and quartzose admixtures, he compares to the Green Mountain series, and suggests that they may be Huronian. To the east of the Laurentian, and apparently occupying a synclinal, in the schists just mentioned, is a series of folded limestones, with micaceous schists, quartzites, and roofing-slates, closely resembling the Taconic rocks of Berkshire County, Massachusetts, and apparently the prolongation of the Taconic belt indicated by Emmons to the east of the Blue Ridge in North Carolina, and described by him as extending northward through Virginia into Maryland. This, Fontaine thinks, may be altered Silurian, but he speaks with doubt. These crystalline schists to the east of the Laurentian axis are designated as the middle belt, and beyond is still an eastern belt of well-defined granitoid gneisses, overlaid by mica-schists with gneisses, often hornblendic, disposed in broad anticlinals and synclinals, with dips of from 40° to 50° to the east and west. These are said to have the characters of the White Mountain series.

Along the western flank of the Blue Ridge, resting unconformably upon the crystalline strata, is a series of sandstones, shales, and conglomerates, rapidly augmenting in thickness to the southwest, and attaining in the middle of the state over 2000 feet, though not over 1000 feet at Harper's Ferry. These strata, which underlie the so-called Calciferous formation, are destitute of all traces of organic remains except Scolithus. They contain in the conglomerates pebbles of the crystalline argillites (Huronian), as well as feldspar and kaolin from the old Laurentian gneisses, showing, as Fontaine remarks, that these crystalline rocks formed the border of the ancient sea. The strata to the northwest have been greatly folded and faulted, so that these beds in many parts plunge beneath the crystalline Huronian schists, the two dipping at high angles to the southeast, though unconformable. The limestones, which, near Harper's Ferry, include a bed of limonite, also dip southeast at a very high angle. In some parts of the valley the foldings and over-

turned dips are such that the Hudson River slates, according to Fontaine, rest upon the Devonian, and even upon the Lower Carboniferous of the North Mountain. Similar observations were long since, in this region, made by Rogers, Emmons, and Lesley. In other parts of the valley, however, this state of things does not exist, and the more ancient slates and conglomerates repose with a high northwest dip on the flank of the Blue Ridge.

An important deduction by Fontaine, from his examinations of the rocks in Virginia, is that there is no ground for the conclusions of H. D. Rogers that the folds of the Appalachian system extend to the Atlantic, and are more compressed next the ocean, while widening out to the west. In fact, the White Mountain rocks of the eastern are less disturbed than the Huronian of the middle belt. "Such a connection does exist between the flexures of the Silurian, Devonian, and Carboniferous areas, but the Blue Ridge is the initial point on the east."

The writer may remark in this connection that these strata from Harper's Ferry, for a few miles east along the Baltimore and Ohio Railway, offer all the types of the Huronian or Green Mountain series, while the gneisses and mica-schists nearer Baltimore present the characters of the Montalban or White Mountain series. Pebbles of these latter rocks, derived from the Blue Ridge, abound in the conglomerates which with sandstones and shales make up the Iron Mountain on the southeast side of the great Appalachian valley in Grayson County, Virginia.

Dawson has lately discussed anew the facts with regard to some of the Eozoic rocks of Canada, recalling his old observation that the post-Laurentian which in Madoc, Ontario, contain eozoon, present also forms like Scolithus. He has again studied the conditions under which *Eozoon Canadense* occurs in its original locality on the Ottawa, in the province of Quebec. The eozoal limestone forms a thick belt in the gneiss, but the eozoon is abundant only in a bed of four feet, which contains bands and concretions of serpentine, and is traversed by veins of chrysotile. Along with these are laminated masses of serpentine and calcite which are entire specimens of eozoon. Fragmental portions retaining the structure of eozoon are also dispersed in layers through

the adjacent beds of limestone, embedded in which are moreover casts in serpentine of small chambers, single or in groups, having the form and mode of aggregation of globigerina, but with the proper wall of eozoon. These he has provisionally named *Archæospherina*. The eozoon is generally preserved by infiltration with serpentine; but some specimens in dolomitic limestone have their canals filled with transparent crystalline dolomite, while the skeleton is still pure carbonate of lime.

In Missouri the published results of the geological survey by Pumpelly and Schmidt have added to our knowledge of the ancient crystalline rocks which rise through the paleozoic strata in the southeastern part of the state, and evidently formed islands in the paleozoic sea. These eozoic rocks consist in great part of stratified petrosilex, often jasper-like, and frequently becoming a feldspar-porphyry; with it are associated argillites and talcose slates, and more rarely layers of quartzite and of crystalline limestone. The rocks have been compared by Hunt with the similar petrosilex-porphyries of Lake Superior and of the eastern coast of New England, where they form a part of the great Huronian series. They are the iron-bearing rocks of Southeastern Missouri, in which the red oxyd is found either in beds, as at Pilot Knob, or, according to Dr. Schmidt, in great veins, as in the Iron Mountain. The granites of the region apparently break through these ancient crystalline strata. Details are given with regard to the numerous deposits of iron, lead, and copper ores in the paleozoic strata, affording important data for a theory of ore-deposits. The lead ores of this region are not confined, as was formerly supposed, to the strata below the Trenton, but are found in the sub-Carboniferous limestones and even in the coal-measures. The similar deposits of this ore in the valley of the Upper Mississippi, as is well known, are in a formation just above the Trenton, and the question is now raised whether throughout this wide region the deposition of this metal went on at intervals throughout the whole of the paleozoic period, or whether it was, as suggested by Dr. Schmidt, introduced into these various formations at a later date.

In the lower Carboniferous a deposit of chert, which in some localities is over one hundred feet in thickness, consti-

tutes one of the principal lead-bearing rocks in the region. The coal in the northeast part of the state is remarkable for occurring in deposits of very limited area, but of great thickness, sometimes as much as twenty-five feet, with very little of the usually accompanying strata. These accumulations are supposed to have been formed in small hollows in the surface of the lower Carboniferous limestone. An artesian well lately sunk in St. Louis, Mo., has a depth of 3843 feet. Beneath forty feet of surface deposits lie the Carboniferous rocks, the base of which was reached at 888 feet. These are directly followed by the limestones and shales of the Trenton or Cincinnati group, measuring 421 feet, beneath which were not less than 2489 feet of magnesian limestones with sandstones and some magnesian slates—the whole resting on red granitic rock, which was penetrated forty feet. Salt water was first met with in the Trenton limestone at 1220 feet, and the lower strata yielded brines which contained seven and eight per cent. of saline matter. The temperature in these lower depths is from 105° to 107° Fahr.

The paleozoic coal-formation of the Appalachian is for convenience divided into a lower and an upper series; the base of the latter being the great Pittsburgh seam, which is a sheet of coal known over a length of 225 miles and a breadth of 100. Many questions have arisen as to the equivalency of the seams in the lower coal-measures in different parts of the coal-field. Counting from the base of the formation, which in Ohio and Western Pennsylvania is found at a vertical distance of from 500 to 900 feet beneath the Pittsburgh seam, Andrews and Fontaine, from their discoveries in West Virginia, have arrived at the very important conclusion that the base of the coal-measures of the lower series on the Kanawha is not less than 3100 feet below the Pittsburgh seam. From this it would follow that in this region there was, at the beginning of the coal period, a vast basin or depression between highlands of older rocks to the southeast and the great plateau of the Waverley sandstones rising toward the ridge of the Cincinnati uplift to the northwest. Nor was it until this great valley had been filled up with 2000 feet or more of coal-measures, including the important coal-beds of West Virginia, that the general subsidence allowed the coal-formation to be spread over the northwest plateau to a depth

of a few hundred feet, which there intervene between the unconformable floor and the Pittsburgh seam. Beneath this lower series in West Virginia is a still lower group measuring 1200 feet in thickness with coal seams, and having at the summit a heavy conglomerate sand-rock. These correspond to the sub-conglomerate coals studied by Lesley in Southwestern Virginia, and to the small coal-beds lately found by the Second Geological Survey of Pennsylvania in the division No. X., or so-called vespertine strata, which lie at the top of the Catskill Mountain group of the New York survey. This series has been studied anew by Professor Hall and Mr. Sherwood, confirming the old view of its geological distinctness, which had been disputed. It has been traced in New York as far north as Schoharie County, and carefully mapped. Six distinct and nearly parallel ridges, synclinal in form, with eroded anticlinals, have been observed, some of them carrying in their shallow folds the vespertine and umbral beds, which farther southward lie beneath the anthracites of Pennsylvania.

Andrews has inquired into the question of the supposed equivalency of the coal seams of the anthracite region with those of Ohio, Western Pennsylvania, and West Virginia, which he regards as still undetermined. He concludes, moreover, from the various conglomerates to be found at different horizons in the coal-measures, that the so-called basal conglomerate in Pennsylvania can no longer be regarded as marking a geological horizon, but has only a lithological significance.

The question whether the coal-formation of the Rocky Mountains is to be classed with the cretaceous or the tertiary has been much discussed during the past year, but according to the late results of Major Powell the solution is very simple. The workable coals, or lignites, as they are often called, extend in this region throughout the whole of the cretaceous formation, which has a mean thickness of 6500 feet, and through the inferior half of the tertiary, including the Upper and Lower Green River beds (1500 feet), and the Bitter Creek beds (3500 feet), making in all more than 10,000 feet of coal-bearing strata, which are overlaid unconformably by newer tertiary rocks. There is, moreover, a want of conformity in this series between the Bitter Creek beds and the

underlying Rock Springs group, which is cretaceous. The strata from which Lesquereux obtained tertiary plants are above this stratigraphical break, by which they are separated from adjacent beds holding cretaceous mollusks. Thus a more careful stratigraphical study has served to harmonize the apparently conflicting evidence of paleontology. The remains of the Dinosaurs of Black Butte are, however, accompanied by tertiary mollusks and plants.—*Record*, 1874, p. lxx.

Beneath the mesozoic rocks, which include jurassic and triassic strata, are immense thicknesses of paleozoic rocks, including Carboniferous, Devonian, Silurian, and Cambrian, the whole series, from the top of the tertiary to the paleozoic base, having, according to the estimate of Major Powell, a thickness of about 60,000 feet. Beneath all these is a series of crystalline schists, of which about 5000 feet have been measured. The crystalline strata of this region, according to this observer, are every where of great and unknown age.—*Record*, 1873, p. xlvii.

Professor Marsh has discussed the cenozoic formations of the West, and pointed out the existence of several great basins corresponding to fresh-water lakes of former periods, which are now filled with deposits whose organic remains enable us to assign them to different divisions of tertiary time. The great Green River basin, lying between the Rocky Mountains and the Wahsatch range, has the Uintah Mountains on the south and the Wind River Mountains on the north. Its nearly horizontal strata, with a total thickness of 6000 feet, rest unconformably upon the lignitic or cretaceous coal-bearing strata (often highly inclined), and have yielded the remains of not less than 150 species of eocene age. This region remained dry land during the miocene time, perhaps much longer, but was afterward submerged, and has suffered great erosion. A still larger lake existed in eocene time to the south of the Uintah Mountains, and at a much lower level than the last. South of the Black Hills is a great miocene area, the White River Lake basin, extending from the Rocky Mountains to the 99th meridian, and from the 40th to the 44th parallel. Its strata, which consist of fine materials, have a thickness of about 300 feet, and rest like the preceding on the cretaceous. This area constitutes the

well-known "bad lands" of that region. Another miocene basin exists in Central Oregon, in great part concealed under more recent basaltic rocks. These strata, which are more or less inclined, and have a thickness of not less than 5000 feet, include in their lower portions a fauna regarded as miocene, but more ancient than that of the White River basin, which is, however, represented in the upper portions of the Oregon basin. Lying in part over the first-named miocene basin was a great pliocene lake, having nearly the same limits as it to the north and west, but with an area about five times as large, and extending eastward and also southward nearly to the Gulf of Mexico. The deposits of this pliocene area, known as the Niobrara basin, attain a thickness of 1500 feet, and contain organic remains which indicate a warm temperate climate, while that of the eocene was tropical, and that of the miocene intermediate between the two. The great erosion which all this region has suffered is well set forth by Dr. Hayden, when he states that from 10,000 to 15,000 feet of strata, from the paleozoic upward, have been removed, leaving only "what may be called remnants behind, occupying restricted areas. The hard and compact limestones of the Silurian and Carboniferous ages are found to a greater or less extent all over the Northwest. They yield much less readily to erosion than the more modern rocks, and are consequently to be found on the summits of the largest mountains 10,000 and 12,000 feet above the sea."

Dr. Newberry, in his lately published volume of the geology of Ohio, has given a full and careful discussion of all the facts known with regard to the superficial geology of the state and the adjacent regions, and has connected them with the hypothesis of land-glaciation. Professor Dana has given his views with regard to the former existence and extent of a great New England glacier.

Mr. George M. Dawson has studied the physical geography and superficial geology of Central Canada between the Rocky Mountains and the great Laurentian axis, which from Lake Superior stretches northwestward to the Arctic Sea. Rising from the lowest plateau of the Red River and Lake Winnipeg, 800 feet above the sea, we have to the west the Great Plains of the middle plateau, 1600 feet above the sea, and the third or western plateau rising to from 2500 to 4000

feet. Over the latter two are abundant deposits of unstratified drift, which in the middle plateau is almost wholly from the crystalline rocks of the eastern range or Laurentian axis and the limestones adjacent, while on the higher western plateau, though boulders from the latter region still abound, more than one half the drift is from the Rocky Mountains. These themselves afford abundant evidence of glaciers. The author conceives that sub-aerial denudation had already given to the region nearly its present surface before the glacial period. He concludes that the phenomena of the drift in these regions do not require to account for them a polar ice-cap, but are to be explained by the action of local glaciers from the Laurentian axis drifted westward across the submerged prairies toward the Rocky Mountains.

In England the nature and causes of the drift formation have been much discussed. The intercalation of stratified deposits in the unstratified drift, and the presence in both of marine remains, apparently indicate for a part, if not the whole, a submarine origin. In order to conciliate these facts with the hypothesis of a great ice-sheet, Mr. Goodchild has attempted to show that none of the phenomena prove the former agency of the sea, but that all these deposits were formed under land-ice, and in part by the agency of sub-glacial streams, the ice-sheet having excavated from their ocean-bed and pushed up on the land the marine deposits in its onward march. There is, however, a strong reaction from this hypothesis in England [*Record*, 1874, p. lxxiv.], and several of Goodchild's colleagues in the Geological Survey of the United Kingdom have opposed him in recent papers, notably Hardman, Dakins, and Ward. The latter observes, "The difficulties involved in the theories of Croll, Belt, Goodchild, and others of the same extreme school, certainly press upon me—and I think I may say also upon others of my colleagues—increasingly as the country becomes more and more familiar in its features." He suggests, from the observations of late arctic voyages, that prevailing winds acting upon the surface-ice, rather than currents, are to be taken into account in considering the distribution of drift boulders, and quotes the language of Sedgwick in 1842, who, referring to the transport of granite blocks from the hills of Cumberland to the shores of the German Ocean, says, "No one, I trust, will

be so bold as to affirm that an uninterrupted glacier could ever have extended from Shap Fells to the coast of Holderness, and borne along the blocks of granite through the whole distance without any help from the floating power of water. The supposition involves difficulties tenfold greater than are implied in the phenomena it pretends to account for. The glaciers descending from the Alps have an enormous transporting power, but there is no such transporting power in a great sheet of ice expanding over a country without mountains and nearly at a dead level."

Campbell, the author of "Frost and Fire," who has devoted, he tells us, thirty-three years to the study of glacial phenomena in both continents, and long held the hypothesis of Agassiz, believing that all Northern Europe had been buried beneath an ice-cap, has been led by further studies in Russia and in North America to reject this view, and declares that from the Caucasus to the Rocky Mountains he sees no evidence of an ice-cap. He adds concisely that "the glacial traces in North America seem to indicate the transfer of oceans with their systems of circulation from one part of the world to another by the elevation and depression of the land."

Kinahan, of the Geological Survey of Ireland, has made known in the western parts of Galway and Mayo a series of crystalline rocks which may be compared with those of our Appalachian belt. They consist of bedded granites and gneissic and hornblendic strata, quartzites, limestones, micaceous and talcose schists, serpentines, steatites, etc., and are divided by the author into three groups, the united thickness of which is estimated at over 10,000 feet. They are wholly without fossils, and are penetrated by granitic and other intrusive rocks. Being overlaid by fossiliferous strata of Silurian (Llandovery) age, it is conjectured by Kinahan that they may be altered Cambro-Silurian rocks. The similar crystalline schists of Donegal, as long since pointed out by the writer, are partly Huronian and partly Montalban. The hasty generalizations and misinterpretations through which in so many regions geologists have incorrectly referred crystalline strata like these to paleozoic or more recent times [*Record*, 1872, p. xxxvii.], have recently received a further illustration in Carinthia, where, on the authority

of Suess, the mica-schists and the granites of Casauna and the Gailthal have been described as Carboniferous, and supposed to be even more recent than certain strata undoubtedly of this age. Stache has shown that, besides the Carboniferous beds, important masses of fossiliferous Silurian and Cambrian strata are present, and that the crystalline schists of the region really occupy a position unconformably beneath the old paleozoic strata.

The evidence accumulates that the whole Cambrian series in Wales, as originally defined by Sedgwick [*Record*, 1872, p. xxxvi.], extending upward to the unconformably overlying May Hill sandstone (the equivalent of the Oneida of the New York system), is a single physical series. The stratigraphical breaks supposed by Ramsay to exist in Wales above and below the Tremadoc rocks are not recognized by Hicks in his recent study of the ancient rocks at St. David's. The two most important paleontological breaks are at the top of the Menevian and of the Tremadoc. The Silurian and Cambrian nomenclature is again much discussed in England, and the fact that the Silurian of Murchison has not and never has had any base-line is insisted upon. Some, with Hughes, follow Sedgwick in confining the Silurian to the strata above the May Hill sandstone, and give to the rocks from this horizon to the top of the Tremadoc the name of Upper Cambrian, originally applied by Sedgwick; while a greater number restrict the name of Cambrian to the strata below the last-named horizon, and give the name of Cambro-Silurian, or that of Lower Silurian, to the Upper Cambrian. Dewalque has investigated the ancient rocks of the Ardennes, in Belgium, and shown that the whole series of the Cambrian from the Harlech to the Tremadoc inclusive, is probably represented in that region.

The researches of J. Arthur Phillips on the metalliferous rocks of Cornwall cover a great variety of important points. He shows, from a large number of chemical analyses and microscopic studies, that the so-called killas are more or less crystalline schists, often containing crystallized magnetite, quartz, chlorite, and hornblende; and points out that, though of very varying composition, they all differ so widely from granite that no reconstruction or alteration of them could ever convert them into this rock, as speculators in geol-

ogy have sometimes suggested. While some of the rocks of this region hitherto called greenstones are shown to be eruptive rocks, many of them are hornblendic schists. The intrusive granites and the elvans or quartziferous porphyries of the region are very similar in chemical and mineralogical composition. It is well known that Sorby, from a study of the vacuities in the minute cavities filled with liquid in the quartz of granites, endeavored, by noting the temperature at which these vacuities disappear from the expansion of the liquid, to calculate the temperature at which such rocks solidified—a result which, if established, would be of great importance to science. The studies of Phillips, however, confirm the previous ones of Zirkel, that the volume of the bubbles in the fluid-cavities has no constant relation to the liquid, so that we can not in this way attain any certain data. Both natural and artificial crystals contain fluid-cavities, with bubbles of various sizes, as well as cavities full of liquid, and others full of gas or vapor.

The vein-deposits of Cornwall, carrying copper and tin ores with quartz, tourmaline, chlorite, calcite, fluorine, etc., have also been the subject of careful studies by Phillips, who sets forth very clearly the evidences of their aqueous origin; and concludes that the repeated widenings of the veins, of which there is abundant evidence, have been due to the expansive force of crystallization in the fissures, as long since pointed out by Hunt for the granitic veins of New England. The original opening appears to have been only a mere comminuted fracture of the rock in a given direction, between the surfaces of which mineral substances have crystallized from solutions, separating the fragments, and thus giving rise to a brecciated vein-stone. The temperature at which these materials have been deposited is supposed to have been often very moderate. From the mode in which quartz crystals are sometimes bent, and also from the fact that in a case where the fissure in a broken mass of crystalline quartz in a Cornish vein has been filled up with tourmaline, crystals of this mineral having penetrated the substance of the quartz, the author ventures the supposition that the quartz preserved for a time a soft and somewhat plastic condition. From the irregular contraction of such silicious masses after the solidification of the base it is suggested

that the stone-filled cavities in the quartz of rocks like elvan may have originated. Phillips has further described in this connection the deposits from a solfatara in California, where a fissure, alternately filled with hot water and with vapors, has upon its walls crystalline quartz overlaid by chalcedony and by a gelatinous silica, which dries to a mass like chalcedony, and incloses a considerable portion of cinnabar. This quartz, which is supposed to be formed by the crystallization of the opaline silica, holds fluid-cavities with bubbles of varying size, as well as gas and vapor-cavities.

In this connection the observations of Daubrée are important. The old Roman baths of Bourbonne-les-Bains, in the department of the Haute Marne, in France, having been lately opened for repairs, there was found in the mud at the bottom of the well a very large number of medals, statuettes, and ornaments in bronze, silver, and gold, offerings in ancient times to the genius of the place. Beneath there was a layer of fragments of sandstone cemented together by crystalline minerals, which were also found incrusting some of the medals. Among these were the various sulphuretted ores of copper, chalcosine, covelline, phillipsite, chalcopyrite, and antimonial tetrahedrite—all distinctly crystallized; together with crystals of quartz supposed to be contemporaneous in origin with the sulphurets. A piece of lead was incrusted with cubical cleavable galena and anglesite, and in other parts of the deposit pyrite and crystals of calcite and chabazite were met with, as in the well-known similar cases of the thermal springs of Plombières and Luxeuil. The waters of Bourbonne, which rise through mesozoic strata, are strongly saline, and contain alkaline and earthy sulphates and chlorids. Their temperature is about 60° Centigrade; and it is clear that it is the action of these waters on the metals during many centuries which has generated these crystalline compounds, which present all the mineralogical characters of the same mineral species found in the veins of Cornwall and elsewhere.

J. D. Dana has described the curious associations of minerals at the Tilly Foster iron-mine in Putnam County, N. Y. The rocks are here hornblendic gneisses of Laurentian age, including beds of magnetite mingled with chondrodite, which is sometimes predominant. It is often associated

with and penetrated by serpentine, and is accompanied by hornblende, enstatite, and chlorite. Veins and fissures cutting these ore-bearing strata are filled with a great variety of crystalline minerals, including those already named and many more. Among these is a mosaic of dolomite and serpentine, both in cubic forms, copied from some undetermined species. These imitated forms are at first described by Dana as pseudomorphous from alteration, but subsequently in the same paper as results of "substitution, and not of alteration;" the latter view being doubtless the correct one, though the precise mode of their formation is still obscure. Besides these, the vein-stones present a great variety of other interesting examples of substitution or replacement of contemporaneous crystallization and envelopment, which are often vaguely included under the name of pseudomorphs. The phenomena to be observed in vein-stones, where minerals have been successively formed in fissures which have been through long periods channels for the circulation of watery solutions of varying composition, alternately depositing crystals, incrusting them, dissolving them, and again depositing others, are exceedingly complicated; but it should be remembered that these various reactions are from the nature of things inapplicable to the solid masses of previously formed rocks.

The examinations of the deposits from deep-sea soundings have much geological interest. It appears from the observations made on board the *Challenger* that the deposit over great areas is a nearly pure calcareous ooze, chiefly made up of the shells of globigerina. Below 2000 fathoms, however, the calcareous matter diminishes in amount, and at 2600 fathoms disappears, a fine red clay, with silicious tests of diatoms and radiolarians, taking its place; while at still greater depths the proportion of clay diminishes, until at length the ooze consists chiefly of the remains of these silicious organisms, which are probably more abundant at great depths, while the foraminifera belong to shallower waters. The absence alike of these organisms and of their remains in deep waters is ascribed to the solvent action of the waters, augmented by pressure, and holding in solution carbonic acid, and the red clay is regarded as the insoluble residue from the globigerina ooze. It is described as a silicate of alumina

and iron-oxyd, and is supposed to be related to the coloring matter of the red chalk of England, which is a silicate in which the iron often greatly predominates over the alumina, and, as Church has suggested, is probably a partially decomposed greensand, or glauconite, which in various parts of the sea-bottom is found, as in older formations, filling the cells of foraminifera, or appearing as casts of these from which the calcareous shells have been removed. The red soil which overlies the white coral-sand of Bermuda is in like manner a silicate containing more iron-oxyd than alumina, and is very unlike a true clay in composition. Whatever may have been the agencies by which the silica, iron, and alumina have been brought together to form the glauconite which after the death of the foraminifer replaces its sarcode, there is no apparent basis for the notion of the organic origin of clays, which has been suggested in this connection. The red clays from great depths contain more or less oxyd of manganese, which sometimes forms concretionary masses several inches in diameter, or coats with a mammillated layer pebbles and bits of pumice-stone in the red ooze. It has been suggested that this may have been accumulated through the agency of algæ, the ashes of some of which contain as much as four hundredths of manganese. The oceanic circulation, which, by carrying to the depths of the sea cold and aerated waters, makes possible these varied conditions of deposition, is, as Carpenter has shown, excluded from basins which, like the Mediterranean Sea, are cut off by submerged barriers from the flow of the polar waters; and hence the deposits at comparatively moderate depths are there almost destitute of organic remains. The bearing of all these facts upon the rock-formations of past ages is obvious.

GEOGRAPHY.

The progress in Geography during 1875 has not been marked by any very striking discovery, although a reasonable average in the way of the extension of our knowledge has been maintained.

The following may be considered as among the more important points in the history of the year:

Geodesy, Navigation, and Hydrography.—An International Geodetical Congress was held on the 20th of September in

Paris, with General Haner, the delegate for Spain, as president. The German, Russian, and Austrian empires, together with Italy, Belgium, Roumania, Switzerland, and several German states, were represented. No delegate was present for Great Britain nor for the United States.

The much-vexed question of the difference in level between the Caspian Sea and Lake Aral has finally been settled by the Russian Commission, which ascertained that the mean height of the latter above the former is 242.77 feet, and 157 feet above the Black Sea. Heretofore the height of the Aral above the Black Sea was supposed not to exceed 27 feet.

The United States Hydrographic Office has published quite a number of important papers; among these may be mentioned the works of Lieutenant Gorringe on the Rio de la Plata, and that of Commander George Dewey on the coast of Lower California and Western Mexico, being the report of the recent cruise of the *Narragansett* in that region. Important information is given here in regard to various points on the coast, including the comparatively little-known Revillagigedo Islands to the south of Lower California, of which Socorro is the type. A report has been made by Lieutenant George F. Totten upon the northwest coast of Spain, and the coast of Portugal from Estaca to Cape Trafalgar. There has also been printed a report upon the soundings of the *Tuscarora* in the North Pacific Ocean.

The Ocean and its Depths.—The public attention is still directed toward the movements of the British surveying-ship *Challenger*, of which so frequent mention has been made in the *Annual Record*. It is probable, however, that her history will soon be closed, as she is expected to return to Great Britain in the spring of 1876. So far she has carried out fully the programme upon which she started several years ago, with the exception, perhaps, of the omission of a portion of the work assigned in the Aleutian Islands and on the northwest coast of America.

Taking up her history at the point to which we brought it in the last *Record*, she left Port Nicholson on the 7th of July, 1874, and proceeded under sail along the east coast of New Zealand, and thence to the Kermadec Islands. She reached Tongataboo on the 19th, from which she proceeded

to the Fijis, where considerable time was spent in detailed explorations.

Leaving Kandaru on the 10th of August, the *Challenger* proceeded to Api, one of the New Hebrides, and thence to Raine Island, near the entrance to Torres Strait, a distance of about 1400 miles. After this she went to Arú—by way of Port Albany and Cape York—and then to the Ké group, and on to Amboyna, which was reached on the 4th of October.

From Amboyna the party proceeded to Ternate, and thence across the Molucca Passage into the Celebes Sea, and by way of the Sulu Sea to Manilla, where they arrived on the 4th of November. The vessel proceeded to Hong Kong, arriving November 16, from which point the collections made were forwarded to England.

Among the more important zoological results of this section of the cruise was the capture of a living pearly nautilus, which was kept for some time for the purpose of studying its movements and attitudes. After leaving the Ké Islands some fine specimens of undescribed species of pentacrinus were collected.

At Hong Kong Captain Nares, who had been in command of the vessel from the first, left, and proceeded to England to take charge of the preparations for the British Arctic Expedition; and the command of the vessel was assumed by Captain Frank T. Thomson, who left Hong Kong on the 6th of January, and reached Manilla on the 11th. Starting from Zebu on the 14th, soundings were taken, and on arrival there magnetic, tidal, and other observations made. From Zebu a run was made to the volcanic island of Camiguin, for the purpose of obtaining the depth of water and bottom temperature close under the volcano. Proceeding thence, after various stoppages, the vessel reached Humboldt Bay, on the coast of New Guinea, by the 23d of February. Here, however, the menacing attitude of the natives prevented landing and conducting further operations. Admiralty Island and Nares Harbor were reached on the evening of the 3d of March, and, the natives being friendly, a survey was commenced the next morning. Finding it impossible to reach Hogolu, in the Caroline Islands, or Guam, in the Ladrones, the steamer proceeded directly to Yokohama, from which place, arriving

April 11, the report has been forwarded. The deepest water obtained during the cruise was found on the 23d of March, in latitude 11° 24′ north, longitude 143° 16′ east, amounting to 4475 fathoms.

A sub-report, by Commander Tizard, has reference to the temperatures of the China, Sulu, Celebes, and Banda seas. It is remarked that the temperatures in the seas of the Indian Archipelago show that they have deep basins, cut off from the general oceanic circulation by ridges connecting the islands which surround them, and that after reaching a certain depth, representing the height of the ridge in question, the temperature remains the same to the bottom, and is of course much higher than would prevail at the same bottom-depth were it entirely open to the general circulation of the sea.

Since that date no information has been received in the United States in regard to the movements of the *Challenger*, beyond the telegraphic announcement of her arrival at Valparaiso on the 19th of November.

The Norwegian Legislature has, it is said, voted the sum of $24,000 for the purpose of prosecuting deep-sea investigations between Iceland, Spitzbergen, the Faroe Islands, and Jan-Mayen Island, the operations to be based upon the model of those of the *Challenger*.

The United States steamer the *Swatara*, which was detailed for service in the American Transit of Venus Expedition, and of which mention was made in the *Record* for 1874, left Hobart Town on the 17th of February, 1875, and reached Melbourne on the 19th. On the 1st of March the homeward voyage was entered upon. Tierra del Fuego was sighted on the 3d of April, and the equator crossed on the 6th of May, in longitude 38°. A short stop was made at Barbadoes on the 16th of May, just eleven weeks from Melbourne, for the purpose of securing a supply of water, and on the 20th she left for New York, where she arrived on the 31st of May, or one year after she had left that city in 1875. She brought back a large number of collections of natural history, gathered in Kerguelen Island, in Tasmania, in Australia, and at Chatham Island, by officers and members of the expedition, prominent among which were Dr. J. G. Kidder and Dr. Kershner, surgeons of the *Swatara*; Mr. J. B. Russell and Mr. Smith of the Coast Survey.

The publication of the report of the operations of the United States steamer *Tuscarora* has already been referred to; and Dr. Carpenter, in discussing her observations made in the deep seas between the United States and Japan, infers the general want of that sub-surface stratum of above 40° Fahr. which in the North Atlantic, with the same or yet higher parallels, has a thickness of at least 500 fathoms. The true cause of this peculiarity is that the North Pacific derives its deep stratum of glacial water, which nearly fills its basin, from the polar area of the opposite hemisphere, the inlet at Behring Strait being too narrow and too shallow to admit a flow of water of any appreciable importance. This northward flow of the water from the equator must have, as its complement, a movement of the superficial stratum from the northernmost limit of this flow *toward* the equator, and thence toward the southern pole. The glacial current when it reaches the North Pacific comes nearer the surface than it does in the Southern Ocean, even in the higher latitudes; and this, modifying still further the reflex surface flow toward the equator, appears to account for the well-known moderation of the climate of the Sandwich Islands, though they lie within the Tropic of Cancer.

The *Shearwater*, a British vessel, completed in 1875 a four years' course of surveying service, having been put in commission on the 20th of July, 1871, and returned to Sheerness on the 23d of July, 1875. She was originally commanded by Captain Nares, who, when transferred to the *Challenger*, was succeeded by Captain W. J. L. Wharton. While on her original duty in the Mediterranean she was employed for a time in prosecuting certain important physical investigations, under Dr. Carpenter, and after two years' service there she was sent to Zanzibar to survey that island and the opposite coast. In February, 1874, the vessel proceeded to the Cape of Good Hope, and left Cape Town July 14, with the Rodriguez transit party, remaining for some time at Rodriguez on specific service. She then transported the transit party to the Mauritius, and again proceeded to Zanzibar to continue her work there.

According to *Nature*, during the four years she has been in commission the vessel has surveyed in detail 790 miles of coast-line, and made many soundings over an area of 5900 square miles.

The Arctic Regions.—The principal event of the year in connection with the exploration of the arctic regions is the fitting out and departure of the great English expedition, of two vessels—the *Alert* and the *Discovery*—under command of Captain Nares, which left Portsmouth for the far North on the 29th of May. For many years past the authorities of Great Britain have been urged by her people to revive the traditional glories of the nation in the matter of arctic exploration; but it was not until 1874 that steps were actually taken in this direction. Once entered upon, however, no pains were spared to render the work a success. All the resources of science were called in to contribute suggestions and information, and no contingency, it is believed, has been left unprovided for that could be in any way anticipated.

The entire expedition is under the command of Captain Nares, of whom so frequent mention has been made in connection with his command of the *Challenger*, his flag-ship being the *Alert*. Her commanding officer is Commander Markham, who during the previous year had visited the arctic regions on board of a whaling steamer, for the purpose of obtaining a practical acquaintance with his new duties.

The *Discovery* is commanded by Captain Henry Stephenson, with the usual necessary staff and subordinate officers. While, of course, all the peculiar physical observations will be carefully attended to, as a part of the naval routine, both vessels have gentlemen on board competent to discharge the duties of ethnologists and naturalists. The two vessels were accompanied as far as Greenland by a third—the *Valorous*—for the purpose of carrying stores and supplies to fill up the other two in Greenland, and to place the remainder of her cargo in dépôts on shore, for any further needs.

As stated, the fleet left Portsmouth on the 29th of May. The first ice was seen on the 27th of June, and on the 6th of July the *Alert* and *Discovery* anchored in the harbor of Godhaven, at the southwest end of Disco, where the *Valorous* had arrived two days before. Here the two exploring vessels were occupied from the 6th to the 15th in filling up with coal and provisions from the *Valorous;* and on the afternoon of that day they proceeded on their journey, stopping

by the way to procure dogs, of which twenty-four were taken on board at Godhaven and twenty more at Ritenbeck.

On the 17th the *Alert* and *Discovery* left Ritenbeck, and the *Valorous* started on her voyage homeward.

On the 19th of July the two former vessels reached the little Danish settlement of Proven, where Esquimau Hans, well known in connection with the *Polaris* expedition, was engaged. Fortunately for the expedition, he consented to go without his wife and children, thus relieving it from a very considerable burden. Here, also, some additional dogs were procured, bringing the total number up to sixty-one.

Information was here obtained in regard to the condition of the ice, and it was learned that the whalers had not been able to get through Melville Bay at first, but that they managed to accomplish this on a second attempt in the second week of June.

Leaving Proven on the 21st of July, they reached Upernavik on the 22d, and, after remaining only two hours, sailed at 8 A.M. of the same day. These are the latest advices received from the expedition, which is now doubtless in comfortable winter-quarters, engaged in prosecuting the researches assigned to it.

The *Pandora*, under command of Captain Young, which sailed in the spring for the purpose of making additional discoveries in regard to the northwest passage, and particularly to obtain further relics of Sir John Franklin, returned to England on the 16th of October, without having accomplished her mission. She expects, however, to start out again in the coming spring.

Disco was reached on the 7th of August, and Upernavik on the 13th, and Cape York on the 16th. The vessel called at the Carey Islands and deposited letters for the *Alert* and *Discovery*, and thence proceeded up Lancaster Sound to Beechey Island, which was reached on the 26th. Here Northumberland House, which was built as a storehouse by the *North Star* in 1850, was inspected, and it was found that it had been broken open by bears and many of the stores damaged, except those in casks and barrels. The two life-boats and the yacht *Mary*, left by Sir John Ross, were found in perfect condition.

After putting the dépôt in order, Captain Young proceed-

ed up Peel Strait for the purpose of reaching King William Land, getting as far as La Roquette Island, near Bellot Strait, on the 30th of August. Here an impenetrable pack of ice across the channel barred all further progress, and, after vainly trying to find a passage, Captain Young prudently determined to retreat, which he did on the 3d of September, and, as stated, the *Pandora* reached home on the 16th of October.

In point of actual results in arctic research during the year, the expedition of the *Pröven*, under command of Professor Nordenskjöld, has been the most successful, problems having been solved which have baffled inquiry for hundreds of years, and a rich harvest of physical and biological results secured. The *Pröven*, on which the party embarked, left Tromsö on the 8th of June, 1875, but was compelled to lie at anchor five days on account of a head-wind. Finally it got under way, and passed North Cape on the 17th, to the southern part of Nova Zembla, where anchor was cast in a bay north of Goose Cape. During the voyage numerous determinations of temperature and soundings were taken, and many collections made, promising many new objects to the naturalist.

From Nova Zembla the *Pröven* proceeded to the Sea of Kara, and on the 26th of July anchored off Waigat Island. It was not until the 30th that a boat could land on the island, on account of a storm. Here many rare silurian fossils were gathered, very similar to those of Gotland. The party met some of the Samoyedes, who had collected to see the vessel.

On the 2d of August the Sea of Kara was reached, and found to be completely free of ice; but, in consequence of the baffling winds, progress toward the middle of the peninsula, called by the natives Jalmal, which separates the Sea of Kara from the Bay of Obi, was very slow. This delay, however, was utilized in making many collections of animals, among which were several new species. The water at the surface, in consequence of the large rivers emptying in the vicinity, proved to be nearly free from salt, forming a deadly poison for the animals which live in the salt-water at the bottom. Most of these when brought up from the bottom died when placed in water from the surface.

An important series of experiments was made with the Negretti-Zambra and Casella deep-sea self-registering thermometers, showing that in the Sea of Kara, as well as off the coast of Nova Zembla, the temperature of the sea-water at the surface is very variable, and dependent upon the temperature of the air, upon the neighborhood of ice, and upon the influx of warm fresh-water from the Obi and Yenisei, but that at the depth of ten fathoms the temperature is nearly or quite constant (between 1° and 2° C.). If in the northern part of the Sea of Kara, where the water on the surface is almost completely free of salt, and at this time of the year very warm, a flask filled with water from the surface is sunk to a depth of ten fathoms, the water becomes frozen. There are thus no warm-water ocean currents here at any considerable depth below the surface. It is believed that the percentage of salt at the bottom is very constant.

On the 8th of August the party landed for a few hours on the northwestern side of Jalmal, where an astronomical determination of the position of the place was made. Traces of men and of Samoyede sledges were visible on the beach. Close to the shore was found a sacrificial altar, consisting of about fifty skulls and bones of the polar bear, walrus, and reindeer. In the middle of this heap of bones were two rude idols, hewn from drift-wood roots, newly besmeared in the eyes and mouth with blood; also two poles provided with hooks, from which hung bones of the reindeer and bear. Close by was a fireplace and a heap of reindeer bones, the latter clearly the remnant of a sacrificial meal.

After a stay of a few hours, the party set sail for the north, until farther advance was prevented by impassable masses of great even ice-fields at 75° 30′ north latitude, and 79° 30′ east longitude. Following the edge of the ice eastward, they finally reached the north side of the mouth of the river Yenisei on the 15th, and they had now attained the goal which great seafaring nations had striven in vain for centuries to reach.

Here the vessel remained engaged in various occupations until August 19, when she proceeded to the northern part of Nova Zembla, and on the 23d of August reached 75° 24′ north latitude and 66° 24′ east longitude—a little south of Cape Middendorff, on the northeast coast of Nova Zembla.

This was the result of a very strong northwesterly current from the Obi and Yenisei out over the Kara Sea.

At Cape Middendorf ice was met with, extending as far as the eye could reach, and the expedition was becalmed for six days, during which time very rich results were obtained by means of the dredge and trawl. Animal life was found to be very abundant and varied; enormous numbers of radiates, crustaceans, and mollusks were taken in a short time. On the 29th anchor was cast in Udde Bay, where marine vegetation was found to be very abundant, contrasting strongly with the scanty land flora.

On the 3d of September the *Pröven* sailed into the mouth of Matotschkin Strait, where the party remained until the 11th of the month, and thence proceeded homeward, experiencing exceedingly tempestuous weather, and arriving at Tromsö October 3d. The vessel sailed over six thousand miles, and visited regions which expeditions for more than three hundred years had vainly attempted to reach, making rich collections in all departments of natural history.

In the mean time Professor Nordenskjöld left the steamer at Port Dixon, and proceeded up the Yenisei in a boat, accompanied by five men, making a very interesting exploration of the river. At the last advices the Professor had reached St. Petersburg (November 27), on his homeward journey, where he was received with the utmost hospitality by the scientific men of the capital. His return to Stockholm has not yet been announced.

In further reference to this subject of arctic discovery, it is stated that Captain Gundersen, recently returned from a voyage to Nova Zembla, found there the journal of Barent, giving an account of his doings from the 1st of June to the 29th of August, 1580.

North America.—For several years past, as shown by the successive volumes of the *Annual Record*, a large part of the activity in exploration in North America has been due to the labors of three government parties; two of them, those of Professor F. V. Hayden and Major J. W. Powell, acting under the Interior Department, and the third, that of Lieutenant George M. Wheeler under the Engineer Bureau of the War Department. The operations of these parties have generally been conducted on a very large scale, provided

with the necessary *personnel* and apparatus for prosecuting researches in geodesy, topography, geology, as well as natural history and ethnology, resulting not only in the accumulation of a large mass of facts, but of many interesting and important specimens as well. The former have been promptly worked up into annual reports of progress, and the latter deposited in the National Museum, in accordance with the act of Congress to that effect, where they occupy a very conspicuous place.

Detailed reports of the labors for the year of these several parties, as furnished by the officers in charge, will be found in the body of the present work, rendering it unnecessary to say any thing further here upon the subject. The final reports of these expeditions, however, deserve further mention. These will be, for the most part, in quarto, and the series for each will embrace about six volumes, some of which are already published. Of Professor Hayden's survey there have already appeared: "The *Acrididæ* of North America," by Professor Cyrus Thomas; "The Extinct Vertebrata of the West," by Dr. Joseph Leidy; "The Cretaceous Flora of the West," by Professor Leo Lesquereux; and "The Cretaceous Vertebrata of the West," by Professor E. D. Cope, the last mentioned having been published in 1875. Several volumes of Lieutenant Wheeler's series are in press, and will be published in the course of 1876. The first volume of Major Powell's report, that on his exploration of the Colorado River in 1869–72, appeared during 1875.

Apart from the labors of the three great expeditions there have been less than usual of miscellaneous explorations in the United States in 1875. In this connection, however, we may mention the labors of the United States Fish Commission at Wood's Hole, Mass. A party, composed as usual of several scientific specialists, established itself at that station, where, with the assistance of the apparatus of the Commission and of the United States steamer *Blue Light*, furnished for its use by the Navy Department, and under command of Captain L. A. Beardslee, a large amount of scientific work was accomplished, including a thorough exploration of the shores of Nantucket, Martha's Vineyard, and the south side of Cape Cod for a considerable distance, as well as of the intervening waters.

Among the gentlemen present were Professor A. E. Verrill, S. J. Smith, and S. F. Clarke, of Yale College; Dr. William G. Farlow, of Cambridge; Professor A. Hyatt, of Boston; Professor Theodore Gill, Mr. G. Brown Goode, and Mr. T. H. Bean, of the Smithsonian Institution; Professor Sanderson Smith, of New York; and Dr. J. G. Kidder, surgeon of the *Blue Light*, and numerous occasional visitors of distinction. The collections were very large, embracing a full representation of the marine life of the region referred to.

A large part of the work of the Commission was devoted to obtaining illustratious of the fisheries of Massachusetts, for exhibition at the International Exposition, including the work of securing photographs, colored sketches, and plaster casts of the cetaceans and fishes generally, either originals or models of the various forms of fishing-craft and of the apparatus used in the fishery business.

Although not coming under the head of geographical explorations, it may be proper to make special mention of sundry ethnological researches, connected with the preparations for the International Exposition, and conducted, for the most part, under the auspices of the Smithsonian Institution and of the Indian Bureau. The first of these to be mentioned is the work of Mr. Paul Schumacher on the islands and mainlands in the vicinity of Santa Barbara, where, with a party of several assistants, he was engaged for several months in making explorations of the graves of the aboriginal inhabitants.

A party, detailed by Lieutenant Wheeler, under Dr. H. C. Yarrow, was also engaged simultaneously, in the same region, for the same object.

After the labors of Mr. Schumacher in the Santa Barbara region were brought to an end, the work was taken up by Rev. Stephen Bowers, and from the three parties an enormous aggregate of interesting objects, and of remarkable variety and beauty, were sent to Washington—the whole reaching a weight of over fifteen tons, composed principally of objects of stone, in the form of mortars, pestles, bowls, plates, etc. Mr. Schumacher subsequently continued his researches in Oregon with satisfactory results.

Mr. James G. Swan, of Port Townsend, was engaged by the Indian Bureau to prosecute researches into the ethnology

of the Indians of Northwestern America, for which purpose he visited Alaska and various points on Puget Sound. Large collections were made by him and shipped to Washington.

Mr. Stephen Powers, well known from his researches into the Indianology of California, was also engaged by the Indian Bureau to make explorations in California and Nevada in search of ethnological objects.

Major J. W. Powell, in addition to his surveying work, made many collections, illustrating Indian life, of pre-eminent value.

The ethnological inquiries of Dr. Edward Palmer in the southwestern portion of the United States, especially in the vicinity of San Diego, have furnished satisfactory returns.

In addition to these more extended and noteworthy researches, numerous investigations of less importance have been prosecuted in the Mississippi Valley and elsewhere, yielding very gratifying results.

For the purpose of securing a proper representation at the International Exposition of the tribes of Northern Alaska, the services of Dr. Bessels were engaged by the Indian Bureau, and the occasion of a cruise of the United States steamer *Saranac*, in northern waters, was embraced by him, with the permission of the Secretary of the Navy, to proceed to the North, for the purpose of making full and exhaustive collections. Unfortunately, the *Saranac* was wrecked not far from Victoria and totally lost, thus putting a summary end to the expedition.

For further information relative to explorations in North America in 1875, reference may be made to the chapter on Geography in the body of this work.

There is little to be said in regard to the work of exploration in Central and South America during the past year. The *Narragansett*, as already mentioned, under Commander Dewey, performed good service in the waters of Lower California and the west coast of Mexico, the results of which have been published in the form of a report.

The labors of Professor Gabb in Costa Rica have been brought to a close, and that gentleman is now engaged in working up his collections and notes, with a view to an exhaustive report, interrupted for a time by a visit to San Domingo. The extent of his collections in general natural his-

tory and zoology has seldom been equaled, and we may safely say that, so far as the vertebrates are concerned, the zoology of Costa Rica is almost as well known as that of the United States. His work in reference to the ethnology of the tribes has also been extremely important. A full series of his collections, biological and ethnological, has been placed by Dr. Gabb in the National Museum at Washington.

Asia.—The *London Geographical Magazine*, which constitutes so complete and exhaustive an exponent of geographical progress, in reviewing the third edition of Colonel Walker's map of Turkistan, takes occasion to give a statement of our knowledge of the progress of geography in Central Asia within the last two years. It remarks that the work of the mission to Kashgaria, under Sir Douglas Forsyth, is especially full of important results, among which are enumerated the correct fixing of the position of certain important towns by astronomical observations, and the survey of about three thousand miles of route lines. The longitude of Kashgar was established at 76° 6′ 47″ east of Greenwich.

Numerous changes of the previous geography in Central Asia, also, resulted from the labors of the Havildar employed on the great trigonometrical survey of the region of the Oxus, with the aid of a Mollah, an assistant of the Havildar.

Another exploration, the materials of which are made use of in Colonel Walker's map, is that in Great Thibet, by the Pandit who was connected with the expedition of Major Montgomerie.

The same journal also furnishes an account of the Olena expedition of the Russian Geographical Society, which left Irkutsk, under the direction of Cherandoski and Müller, in 1873, for the purpose of penetrating to the sources of the Olena River, and thence to the shores of the Arctic Ocean. This was carried on with varying success, and on the 1st of November, 1874, the travelers reached the mouth of the Olena, having thus completed the first part of the enterprise.

No very recent information has been published in regard to the operations of the present year, but it was expected that the basins of the Anabara and Khatanga would be investigated.

This expedition has added a great deal to the knowledge of the geography of Siberia, and the magnetical observations

have developed the important fact that the Siberian pole of greatest intensity is between latitude 64° and 65° north and in about longitude 112° east, and just about 7° west and south of the position assigned to it by Gauss. The minimum temperature observed during the expedition was —49°, in latitude 61° 30′ north; the absolute maximum was 82.36°, on the 1st of June, in latitude 66° 26′. The expedition crossed the polar limits of several trees. The silver-poplar first disappeared, then the silver-fir, in latitude 60° 50′. The birch was found as far north as latitude 63° only.

Details in reference to the geographical discoveries in Northern Asia will be found in the account of Professor Nordenskjöld's journey to the river Yenisei.

A British expedition left Rangoon in the latter part of December, 1874, to re-open the old trade route between Burmah and Yunan. This was in charge of Colonel Horace Brown, accompanied by Mr. Ney Elias as topographer and John Anderson, director of the Museum of Calcutta, as medical director and naturalist. The party was accompanied by an escort of soldiers, and provided with Chinese interpreters and a guard. We learn, however, that after the expedition had reached the borders of China it was attacked by fanatical natives and entirely broken up, so that nothing was accomplished.

Nothing definite has been received in the United States in regard to the expedition to Western China, under the command of Captain Sosnovsky and Captain Matvosovsky, accompanied by a surgeon, photographer, and interpreter. They reached Shanghai by way of Kiachta and Pekin, and were to leave Hankow by steamer, and afterward to proceed westerly up the river Han in native boats.

The two explorations of Palestine, the one under American auspices and the other under British, have been continuing their work during the year with varying success. The British party in the early part of the year engaged in the examination of the southern portion of their field, which they expected to finish during the summer. At that time Lieutenant Condon reported that he had a list of nearly 3000 names in Arabic, and that he had fully identified Bethabara as the place where John was baptized. Upward of fifty fords of the Jordan were discovered in the progress of the survey. Sub-

sequently to that date, an attack by Arabs upon the party resulted in its temporary disorganization and a serious interruption to its labors.

The American party has also been doing good work. Reinforcements were sent out, under the direction of the American Palestine Exploration Society, from New York, on the 19th of June, on board of the steamer *Celtic*. The party consisted of Colonel J. C. Lane, of Brooklyn, commanding the expedition, J. Harvey Trent, of Lawrence, Massachusetts, and Professor Selah Merrill, of Andover. They were to be joined in Europe by Mr. Rudolph Meyer, who has preceded the party to make some preliminary arrangements. They took out a large supply of engineering instruments of American make, and will remain two years in Palestine, the expenses being guaranteed by the friends of the society.

Africa.—The interest in the exploration of this part of the world centres mainly around the labors of Mr. H. M. Stanley and of Lieutenant Cameron. It will be remembered that after his successful search for Dr. Livingstone, Mr. Stanley returned to the United States, and subsequently undertook a second exploration of the interior of Africa under the joint auspices of the London *Daily Telegraph* and the New York *Herald*. Starting in at Zanzibar in 1873, Mr. Stanley reached the Victoria Nyanza in 103 days, after a march of 720 miles, having experienced great hardships on the route, and the loss by disease and fighting with the natives of more than half his party. In further detail of this trip it is to be mentioned that at the village of Muhalala, in the district of Usandawi, the guides whom he had engaged at Ugogo deserted and left him in the wilderness. The march thence was an extremely trying one, and six of his men died; and when he at last reached Uveriveri the whole of his men were exhausted by hunger and fatigue. Failing to obtain sufficient supplies at this point, Stanley sent twenty of his party to Suna for a supply of grain. They succeeded in their mission; but during their absence two more men died.

On the 21st of January Stanley reached the village of Vinyata, in the district of Iturn, and in the valley of the Liwumba River, which he considers the most southerly source of the Nile known. It flows toward the west, and where he reached it there were numerous villages surrounded

by plantations, having a population of from two to three thousand souls. After a time the inhabitants were induced to supply provisions; but the sight of Stanley's stores led to an attack on his camp, which was repulsed with a loss of fifteen on the part of the enemy. A second attack was also repulsed, when Stanley sent out four parties with orders to destroy the villages and to seize the cattle. He lost at this time twenty-one men, and on the 23d he left with a stock of provisions for six days.

On the 28th he reached Mgongo Membo, in Iramba, where he found that out of the 314 men with whom he left the coast only 194 remained. Proceeding farther toward the lake, and penetrating through the jungle bounding the western side of the basin of what is apparently an arm of the Nyanza, Stanley entered Usukuma, which he describes as a densely populated country, abounding in cattle, and finally reached the Nyanza on the 27th of February, 1875, at Kagehyi, one of the principal ports resorted to by slave-dealers, in the district of Uchambi. Here his force numbered only three Europeans and 166 natives. A careful discussion of the temperature of the boiling point indicated an altitude of 3808 feet, the aneroid giving 3550 to 3675 feet.

At Kagehyi Mr. Stanley launched a light boat which he had carried in pieces from the coast, and embarking on the 8th of March, with a picked crew, he circumnavigated the lake in 57 days. He found the physical aspect of the shores to vary considerably, in places being quite high, and again composed of marshy plains. The island of Ukerewe, perhaps the largest in the lake, was found to abound in cattle and ivory. As his circumnavigation continued, numerous encounters took place with the natives, in all of which Stanley was victorious.

At Beyal Island Stanley was welcomed by a fleet of canoes, sent by King M'tesa, of whom he speaks in the highest terms. The king and his officers now profess Islamism, and dress in Arab costume; but he is, nevertheless, said to be anxious to receive Christian missionaries. The daily butchery of men and women has been stopped entirely. On this expedition Mr. Stanley had the good fortune to meet M. Linant de Bellefonds, one of Colonel Gordon's officers, to whom he intrusted a letter. This young officer, with thirty-six of

his followers, was massacred by the Bari on his return to the north, and Stanley's letter was flung aside, but was afterward found by a detachment sent out by Colonel Gordon.

On the 17th of April Stanley left Murchison Bay, on his return to the south, and was accompanied by an escort as far as the Kotonga River. Leaving this river on the 20th of April, he returned to Kagehyi on the 5th of May, where he found that Frederick Baker, one of his European servants, had died on the 23d of April.

The area of Lake Nyanza is set down as 25,300 square miles. It is stated by the *Geographical Magazine* that Stanley's observations and those of Speke agree very closely, the difference in the estimates of the two explorers being very slight.

The result of the labors of Lieutenant Cameron is, if any thing, found to be more important than that of Stanley, as being through a less-known region, and solving a still greater geographical problem. This officer of the British service left the eastern coast, near Zanzibar, on the 24th of March, 1873, reached Ujiji on the 21st of February, 1874, left for the west coast on the 18th of May, 1874, and arrived at Loanda in November last. It appears that he was not able to follow the Congo on leaving Lake Tanganyika, but was obliged to take a more southerly course; but allows the inference that the lake is really the head of the Congo River, as recently maintained.

Nothing very definite appears to have been received from the expedition of Colonel Gordon, which had for its object, in part, the exploration of Lake Nyanza. No later advices have come to our knowledge than that of the arrival of Lieutenants Watson and others of his party at Gondokoro on the 8th of December, 1874. From that point they were to proceed to the exploration of the Nyanza in a boat previously prepared at a station near the falls that obstruct navigation between Gondokoro and the lake.

The official reports of the exploration of the Ogowai River by Messrs. Compiégne and Marche have been published by the Geographical Society of Paris. The London journals, however, do not consider the results of their labors as adding very materially to geographical discovery.

Some months ago it was stated that an expedition was

shortly to leave England for the purpose of making a survey of the coast of Africa opposite the Canary Islands, with a view of finding a suitable position for a harbor and a commercial and missionary station; to enter into commercial arrangements with the native tribes; to inquire into their present means of commerce and the resources of the countries through which it is proposed to pass. It was proposed also to examine as far as practicable the sand-bar across the mouth of the River Belta, which is supposed to keep the waters of the Atlantic Ocean from flowing into the dry bed of the ancient inland sea; and also to obtain levels and other necessary information.

Mr. M'Kenzie, whose name has been previously mentioned in connection with the project of converting the interior of Northern Africa into an inland sea, from the west coast rather than the north, is director of the party.

Australia and Polynesia.—The most interesting advance in our knowledge of the region embraced within this district is that which relates to New Guinea, several expeditions having been engaged in exploring the accessible portions of the coast. In May last the bark *Chevert* was fitted out by Mr. William Macleay for the purpose of geographical and biological exploration; and, accompanied by a picked crew of twenty men, a physician, and four zoological and three botanical collectors, and provided with a steam-launch, he left on the 18th of that month. Their route was by way of Percy, Palm, Brookes, and Cape York Islands; and at the end of six weeks the *Chevert* dropped anchor off the mouth of the Katow River, close to the New Guinea village called Mobato. The steam-launch was then fitted out for an exploration up the Katow, which at its mouth is 200 yards wide. It was, however, impossible to proceed very high up, in consequence of the obstruction from the trees. Returning, and finding a second attempt impracticable, sail was made for Darnley Island, where some time was occupied in killing the large pigeons of Torres Strait. They then proceeded to Hall's Sound, on the east side of the Papuan Gulf, and anchored off Yule Island, where they found an Italian naturalist, D'Albertis, who has been engaged for so many years in the exploration of the northern coast of New Guinea.

From this point the *Chevert* proceeded to Somerset Island

to await news from Sydney; but after a time, in consequence of some misunderstanding between the captain and the party on board the vessel, returned to Australia, without having accomplished the objects for which it started out.

About the same time the missionary steamer *Ellangowan*, having on board the Rev. Mr. Macfarlane, of the Straits Mission, accompanied by a naturalist, left Somerset for the southwest coast of New Guinea, and on the 1st of September reached the mouth of a large river, hitherto unknown, and which they called Baxter River, being one of the finest in New Guinea. Its mouth was one and a half miles wide, and the depth nine to twelve fathoms. The position is said to be 9° 8′ south latitude, 142° 18′ east longitude. At a distance of fifteen miles up the river it was fully half a mile wide, and the depth of water seven fathoms. As the vessel proceeded upward the river banks became bolder, and the timber assumed a formidable growth. The river still continued wide and deep, and at intervals was fed by tributaries of such size and appearance as to render it a matter for much discussion which stream to select. The up-river voyage extended to a distance of ninety miles from the sea. Here they saw birds-of-paradise, and killed a boa-serpent 15½ feet in length. A gigantic bird, the spread of whose wings was supposed to be 15 to 16 feet, was started to flight, but could not be captured.* The tracks of enormous wild animals were observed, one of them supposed to be a species of buffalo.

Further information in regard to Australia, Torres Strait, the southwest of New Guinea, and the western islands of the Luciad Archipelago, is furnished by the report of Captain John Moresby and his companions, in the British steamer *Basilisk*, which was engaged in 1873 and 1874 in surveying these regions.

Captain Moresby remarks that the natives of the south-

* These dimensions have probably been exaggerated, as D'Albertis has sent home what is doubtless the same bird—a species of eagle—which, though of great size, does not quite come up to the claims of the officers of the *Ellangowan*. This has lately been described by Salvadori as *Harpyopsis novæ guineæ*, closely allied to the Harpy eagles of South America, and, like them, living on small mammals. It measures 35 inches in length: wing, 19; tail, 16½; tarsus, 5¾; middle toe and claw, 8¾.—*Annali del Mus. Civico di Genova*, 1872, vii., 682.

west portion of New Guinea are copper-colored, about five feet three inches in height, and with good features. The hair of the men is worn frizzled out in a large mat, and ornamented with feathers; that of the women is always cut short. Both sexes go almost naked. Their weapons are wooden spears and swords, clubs, slings, and stone V-shaped hatchets; but no bows and arrows are seen among them.

Human jaw and spinal bones are worn as bracelets and ornaments, and the wearers appeared to wish to have it understood that they had eaten the original owners of the bones. The houses are built, after Malay fashion, on poles raised five or six feet from the ground, and consist of one large apartment, with peaked gable ends and a saddle roof. Dogs, cats, and pigs are kept; also tame cassowaries, birds, and a small species of opossum bear.

Their fishing-nets are similar to an English seine, with shell sinkers and light wood floats, and are from one to twenty fathoms in length. The material is made by the women, from the fibre of a small, nettle-like plant, and possesses the strength of ordinary seining twine.

MICROSCOPY.

I. MICROSCOPIC APPARATUS AND OBJECTIVES.

In a paper upon microscopic spectrum apparatus, by Mr. H. C. Sorby, and published in the *Monthly Microscopical Journal*, May, 1875, he proposes for the future to adopt the plan of expressing the position of the absorption bands in terms of wave-lengths, instead of referring to an arbitrary scale. He states that probably it is a true general law that when the spectrum of a substance contains a number of well-marked absorption bands, they are related to one another in a perfectly definite manner, and a far more uniform connection exists between the wave-length of their centres than between any other condition. When the relation between the bands in different closely connected compounds is observed by the wave-length method, a relation is recognized which would not be possible if any arbitrary scale were adopted, and this not only when the physical state is the *same*, but when the substance itself is *chemically* modified. In view of this relation between the spectra of compounds known to be related in a simple manner, and which can be

changed one into the other, it becomes a question of much interest to consider whether, when we meet spectra having similar relations, the substances may not be in some way connected, although it may be impossible to convert one into the other. Mr. Sorby gives several striking examples of these equal ratios, though the actual wave-lengths are very different, produced by different coloring matters, and which appear to show that some simple but unknown molecular or chemical combination really exists between them.

A self-centring turn-table, by Mr. C. F. Cox, is described in the March number of the *Monthly Microscopical Journal*, which will meet a want often felt by those who bestow any care upon neatly mounting their preparations, and especially when cells are to be prepared for reception of opaque objects.

In the August number of the *Journal of the Quekett Microscopical Club* is a description of an ingenious arrangement for cleaning very thin covers without breaking them. It consists of a small tube of brass or steel, about an inch in diameter, and the same in height, into which fits loosely a weighted plug. To the lower end of this plug is cemented a piece of chamois leather. Another piece of leather is stretched upon a flat piece of wood or plate glass to form a pad, which completes the apparatus. The tube being placed upon the pad, the moistened thin cover is dropped into it, and the weighted plug placed on it; holding the tube well down on the pad, one can rub as much as necessary without any danger of breaking, the weight of the plug giving sufficient pressure to clean the glass. The manipulation is quite easy, and it is difficult to break the glass.

Mr. Wenham describes in the April number of the *Monthly Microscopical Journal* a new "Method of obtaining Oblique Vision of Surface Structure under the Highest Powers of the Microscope." He advises the use of slips of glass about four tenths of an inch wide, ground and polished at an angle at one edge. The object to be examined is placed upon the sloping plane. One of the slips is cemented to the ordinary three-by-one-inch slide, and the other slip being slid against it, the object will lie flat between the two inclines. It is necessary to have the two inclines to remove the objectionable color which would otherwise enter into the objective. He

recommends an angle of 35° for dry and 45° for balsam-mounted objects. These prismatic slips can be cheaply and easily made by grinding and polishing, say, a hundred at a time, and will no doubt be brought often into use in deciding whether certain appearances in the ordinary mode of view are or are not illusory.

In the April number of the *American Naturalist* is a description of a simple "spring clip" for use in mounting microscopic objects, the invention of Mr. N. N. Mason, of Providence, Rhode Island.

We learn from a contemporary that in order to facilitate the microscopical examination of the eye in cases of disease, M. Monoyer has contrived a modification of Siebel's ophthalmoscope, so arranged that three persons can make simultaneous observations.

Dr. Golding Bird, in an article in the *Quarterly Journal of Microscopical Science*, January, 1875, strongly advocates embedding in elder pith for the purpose of making microscopical sections. He employs for this purpose the pith of the common elder; it is split longitudinally, and a small furrow made with the finger-nail on the cut surfaces of each half, somewhat corresponding in depth to the thickness of the tissue to be cut, receives the specimen; it is then placed in the microtome, and put into water; in a few minutes the pith will have swollen sufficiently to hold the specimen firmly in its place, and the sections are made by means of a razor dipped into spirit.

Wenham's Reflex Illuminator.—Mr. Samuel Wells writes as follows to the *Boston Journal of Chemistry*, June, 1875: "I find that some immersion objectives are capable of transmitting the extremely oblique rays that pass through the illuminator so as to give a bright field when used on balsam slides. In dry mounts the light can not be transmitted beyond the upper surface of the slide, but in balsam-mounted slides the light passes to the upper surface of the cover and is there totally reflected. If an immersion objective is adjusted and connected with the cover by a film of water, the total reflection will be destroyed, and the light will pass through the cover and water into the front of the objective. The ultimate direction of the ray of light after passing through the illuminator is not changed by the introduction of the

different media (balsam, glass, and water), and the angle at which it enters the objective must therefore be greater than 41°. In examining Möller's *Probe-Platte*, a balsam mount, under these conditions, with light from a kerosene hand-lamp, I easily resolved the *Amphipleura pellucida*; so clear and decided were the lines that with a power of 8000 they were still visible.

"The resolution of this difficult diatom, as well as the *Frustulia Saxonica* and *Nitzschia curvula* (Nos. 18 and 19 on the *Probe-Platte*), far surpasses any that I have ever seen by artificial light, and rivals the beautiful resolution obtained by monochromatic sunlight. With this illuminator it is much easier to resolve the *Amphipleura* in balsam than to resolve it dry with any other artificial illumination. The advantages of the reflex illuminator in thus furnishing light of greater obliquity than has been obtained by other methods seem to me worth considering by those interested in testing the resolving power of objectives.

"It is advantageous to connect the illuminator with the slide by glycerin, instead of water, as it does not evaporate. The higher refractive power of glycerin makes no difference in the ultimate direction of the light.

"With high amplification the lines of the *Amphipleura* become decidedly beaded, but do not separate into dots."

We commend to the careful reading of microscopists and microscope-makers the excellent paper of Mr. Slack, read before the Royal Microscopical Society of London, May 5, 1875, and the discussion thereon, contained in the June number of the *Monthly Microscopical Journal*. The paper is entitled, "On Angle of Aperture in Relation to Surface Markings and Accurate Vision." Mr. Slack proves, from the results already accomplished by Zeiss, of Jena, working under the direction of Professor Abbe, that resolving power and penetration are not in that condition of irreconcilable hostility generally supposed, and that a new era is dawning upon physiologists, and, indeed, all who care for something more than the mere display of diatom dots. It is well known that in the extravagant desire to display these dots angular aperture has been pushed to an extreme, and a certain amount of chromatic error allowed as necessary to sharpest definition. By very careful construction, centring,

and elimination of errors, the objectives of Zeiss, *e. g.*, a one-quarter inch of forty-eight degrees, and a one-sixth inch of sixty-eight degrees, will perform work, as Mr. Slack proves, hitherto supposed to be only within reach of the most expensive large-angle objectives. Zeiss has, so to speak, minimized angles of aperture, and secured great working distance and penetration, and yet obtained the amount of separating and resolving power of much larger angled objectives. Mr. Slack truly observes that opticians have been encouraged to make excessive apertures substitutes for good corrections, and that naturalists and physiologists have been too contented with feeble resolving powers, under the belief that any more capacity for resolution must mean less penetration.

Not indirectly connected with this subject of large angle is the "Measurement of the Möller Probe-Platte," by Professor E. W. Morley, reported by J. E. Smith, in the same journal. The measurements were made by means of a Tolles one-sixteenth and a Troughton and Sims micrometer. Professor Morley's measurements are, no doubt, pretty accurate, but any one who knows any thing about diatoms also knows that the number of striæ in 0.01 inch, is subject to considerable variation in the same species. In a communication to the Memphis Microscopical Society, he states as a result of his measurements of the striæ of *Amphipleura pellucida* that they number 92,600 to the linear inch.

The perfection of objectives is yet far from being attained, as we have now Mr. Tolles, with his new system one-tenth surpassing the best work hitherto even with his one-fiftieth; and Messrs. Powell and Lealand, at a recent soirée of the Royal Microscopical Society exhibited a one-fourth and a one-eighth on a new formula, the first resolving *Amphipleura pellucida*, and the other showing *Pleurosigma angulatum* $\times$ 4000, under the most difficult test of direct light, in a remarkably magnificent manner, the beads standing out like minute spheres. At the same meeting Messrs. Beck exhibited a large microscope in solid silver, fitted with every conceivable piece of apparatus, all in silver. This luxurious work of art, intended for an American microscopist, cost some £500.

In the *Monthly Microscopical Journal* for February, 1875,

is an important paper by Dr. Pigott on the invisibility of minute bodies, subtending a sufficient visual angle to be readily seen if properly defined. This invisibility depends upon several causes, which are examined, and the results given in detail; and, first, for minute gas bubbles (vacuum bubbles?) in plate glass: these examined by the horizontal microscope, placed opposite the window, give a very perfect picture of the prospect in miniature; the field of view precisely *three fifths* of the diameter of the bubble, and the marginal band *one fifth*—the same for all objectives, *whatever be the aperture.* Not so with a solid spherule of the same size and same glass, for, first, the marginal band increases in breadth from nothing till it occupies the whole spherule as the aperture is diminished; and, second, the degree of aperture at which the band first appears varies with the refractive index of the bead. If a small spherule be formed by melting the end of a fine glass thread, and examined under the microscope, using the plane mirror before a window, a minute image of the window appears, *surrounded by a black annulus,* which Dr. Pigott calls the "black test-band," it will be found that for the same aperture *the breadth of the black ring is exactly in the same proportion* to the diameters of the spherules; the angular aperture is at once shown by the breadth of the *picture* displayed within the spherule. On increasing the aperture the picture becomes larger and larger, until with a large aperture the ring is attenuated exceedingly; and upon diminishing the aperture exceedingly, the test-band widens so much that only a minute picture is left in the centre. It is evident that this test-band has a remarkable effect upon definition. If we are observing minute spherules in a mass, with excessive aperture, the bands become almost invisible, the forms of closely packed beading, if refractive and transparent, can not be descried, and if there be brilliant illumination, the forms under inspection are completely obliterated.

The Rev. Dr. Edwards, of St. Chad's College, Denstone, England, proposes for the unit of linear measurement in microscopical observations the wave-length of, say, yellow light, or, perhaps better, of orange; in this latter case we would have 1,500,000 wave-lengths = 36 inches, and, in round numbers, 1 wave-length = the $\frac{1}{40000}$ of an English

inch. He states, with true English pertinacity, that though the Committee of the British Association have from time to time recommended the French meter for the unit, Englishmen will not become Frenchmen, and adopt a unit that theoretically holds good only when measured across the territory of the French republic.

The artificial production of silica films, with a view of adding to our knowledge of high power definition, and possibly throwing light upon questions of crystallization and organization, has received a new impulse in Mr. Slack's discovery that the gas escaping from a heated mixture of powdered glass, powdered fluor-spar, and sulphuric acid (and which, when received into pure water, deposits the silica suddenly and violently in amorphous particles), gives delicate films with definite forms, exhibiting remarkable regularity of size and arrangement when conducted through a mixture of glycerin and water. Some of the films produce the beautiful polychromatic effects so often noticed in beaded diatoms and scales.

In the August number of the *Monthly Microscopical Journal* is a paper by Dr. George D. Beatty, of Baltimore, reprinted from the Cincinnati *Medical News*, on "Double Staining of Wood and other Vegetable Substances." The author states that benzol fixes the anilines when used in staining tissues, and also renders them transparent. The double staining the spiral vessels, *e. g.*, of leaves red, and the other parts purple or blue, is obtained by immersing the section for five or ten minutes in an alcoholic solution of roseine (Magenta), and afterward in Nicholson's soluble pure blue for thirty or ninety seconds, rarely longer, with examination during this time to decide upon the proper instant for fixation by immersing in the benzol. We commend the article to those interested in this subject.

Blood.—In a paper read at a late meeting of the Zoological Society, Professor Gulliver stated that in the mammalia the largest red corpuscles of the blood are those of the two elephants, the two-toed sloth, and the walrus. In the human subject the corpuscles are exceeded in size by those of only eight or nine exotic mammalia, and not equaled in size by the corpuscles of any British animals of the class. And this fact, independently of its physiological interest, may prove

important in medico-legal inquiries, since by it alone, as Dr. Joseph G. Richardson states (and as we have already noticed), he has correctly distinguished dried stains of human blood from those of the ox and sheep.

In the September number of the *Monthly Microscopical Journal* is a paper by Dr. Osler, "On the Organisms in the Liquor Sanguinis;" it was read at a meeting of the Royal Society, and has elicited considerable notice. He was not able to trace any organic continuity with any other recognized animal or vegetable form, or to show that they possessed power of reproduction, or were at all related to *Bacteria*.

Dr. Joseph G. Richardson, in a paper presented to the Royal Microscopical Society, and published in the January number of the *Journal*, makes the strong statement that the "pigment-cells," or "scales," described by Frerichs, of Berlin, as occurring in blood, and the "pigmentary particles," or celloids, figured by Dr. Roberts, of Manchester, England, in his treatise on "Urinary and Venal Diseases," are simply and solely *accumulations of dirt*, especially the remains of blood corpuscles, in the little excavations on slides in ordinary use! This is a strong statement, and worthy of serious consideration; but Dr. Richardson is so confident of the truth of his assertion that he challenges any devout believer in pigment-flakes to bring him an honest specimen of blood or urine from any ordinary case of disease, in which can be demonstrated either pigment-flakes, pigmentary particles, or pigment-scales.

M. Laptschinsky, of St. Petersburg, contributes a paper to the *Centralblatt* on the microscopic changes undergone by the blood in various diseases. Where febrile symptoms are present, the changes consist in the blood-corpuscles not running into regularly formed rouleaux, but in accumulating in heaps or clumps, while the individual corpuscles frequently appear swollen and cloudy. In the interspaces of the clumps of red corpuscles, great numbers of white corpuscles may be seen. Careful enumeration of the relative numbers of white and red corpuscles, the former showing unusually active and extensive amœboid movements, satisfied him that in febrile diseases, and in Bright's disease, the conversion or development of white corpuscles into red is either materially retarded or entirely arrested.

The Microscope in Geology.—A valuable paper on the microscopic rock-structure of some ancient and modern volcanic rocks was lately read before the Geological Society by Mr. J. Clifton Ward. In this paper he gives the details of structure of some modern lavas, showing that even in such modern lava-flows as that of the Solfatara, considerable changes had taken place by alteration, and the replacement of one mineral by another, and this very generally in successive layers corresponding to the crystal outlines. With regard to the ancient lavas and ashes of Cumberland of lower Silurian age, they resembled the Solfatara graystone, and though in external structure having more of a felditic than a basaltic appearance, in internal structure they have considerable analogies with the basalts, while in chemical composition they are neither true basalts nor true felstones.

In the case of the Cumbrian ash-rocks the most intense metamorphism had taken place; and the author states that neither the careful inspection of hand-specimens, nor the microscopic examination of thin slices, would in all cases enable truthful results to be arrived at, but that these methods and that of chemical analysis must be accompanied by a laborious and detailed survey of the rocks in the open country.

Botany.—We notice as worthy of attention the articles now in course of publication in the *Monthly Microscopical Journal*, by Thomas Taylor, microscopist of the United States Department of Agriculture, "upon certain fungi parasitic on plants." In the March number he describes the "black knot" of cherry and plum trees, and the *Oidium tuckeri* found on the vine. The latter appears to be not a true mould, but merely a condition of *Erysiphe*, a true parasite of the vine, which will not fruit when removed from the plant on which it grows.

Hitherto no Diatomaceæ are certainly known to have been found earlier than in tertiary deposits. The few so-called diatoms found by Dr. White in the hornstone of the Devonian are exceedingly doubtful. We should scarcely expect silica imbedded in silica to be very visible. Very recently Count F. Cartracane, a well-known microscopist, states, in the *Naturforscher*, that he has proved the existence of Diatomaceæ during the coal period. A piece of Lancashire

coal was pulverized and exposed to a white heat; the decarbonized dust was treated with acid and chlorate of potassa, washed clean with distilled water, and placed under the microscope. Many diatoms, almost exclusively fresh-water genera, and species now living, were found. A piece of cannel-coal from Scotland and another from the St. Étienne mines gave the same result. The experiment needs repeating to prove that these organisms from the coal epoch to the present time have undergone no perceptible modification.

In the *Monthly Microscopical Journal* for September, 1875, is an interesting paper by Worthington G. Smith on the resting spores of the potato fungus, or the "new" potato disease, as it has been called, and he shows that it is no other than the old enemy in disguise, *Peronospora infestans*, in an unusual and excited condition. The article is well illustrated, and worthy the attention of microscopists interested in the study of these parasitic organisms. In the same journal is the conclusion of Dr. Bastian's address on the microscopic germ theory of disease, in which he insists that the facts already known abundantly suffice to displace the narrow and exclusive vital theory, and to re-establish a broader physico-chemical theory of fermentation, and that the original notion, borrowed from the vital theory of fermentation, that all the organisms met with in a fermenting mixture are strictly lineal descendants of those originally introduced as ferments, must disappear with the vital theory itself, and with it the old explanation of the mode of increase of contagium within the body.

A paper of some interest on the *sphæraphides* in plants appears in the *Monthly Microscopical Journal* for December, 1874. The author states that in *Urtica dioica*, *U. urens*, and *Parietaria diffusia* the leaf blades are studded with sphæraphides about $\frac{1}{833}$ of an inch in diameter, composed mainly of carbonate of lime; smaller forms, with projecting crystalline points, and composed of oxalate of lime, occur in the fibro-vascular bundles of the leaf; the same two kinds abound in the leaf and pith of *Humulus lupulus*.

Dr. Bastian delivered an address lately before the Pathological Society of London, on the microscopic germ theory of disease. The conclusion he has arrived at is opposed

to the two forms of the "germ theory" of Dr. Sanderson and Dr. Beale, and, indeed, adverse to the holding of any germ theory in the only form in which it may be at all tenable. No doubt a lively discussion will be elicited, but we much doubt whether any conclusion acceptable to all will be arrived at.

Infusoriæ, etc.—At a recent meeting of the Academy of Natural Sciences in Philadelphia, Dr. Leidy described a curious rhizopod found in a mill-pond, and measuring $\frac{1}{100}$ of an inch in length. It moves slowly with a snail-like motion, and protrudes numerous papillæ and processes which bristle with rigid spicules, which can be shortened or withdrawn—a peculiarity that separates the animal so widely from its nearest ally that it probably belongs to a distinct genus. It is therefore named by Dr. Leidy *Dinamœba mirabilis.* A very curious and interesting discovery of what appear to be fresh-water polycystinæ has lately been made, and a paper embodying all at present known with regard to them may soon be expected from Mr. George W. Morehouse; hitherto they have been considered exclusively marine, and are found in the deepest sea soundings, where, either from the solution of the carbonate of lime or other cause, the foraminifera have entirely disappeared. The lamented Professor H. J. Clark published in 1866 in *Silliman's Journal* a paper in which he maintained that the sponge was an aggregation of flagellate infusoria, a compound protozoan animal; the same view had been substantially announced a little before by Mr. Carter. Haeckel has more recently modified this view, contending that the flagellate monads of Clark are simply cells lining the general stomach cavity of the sponge, and that therefore it is not a compound infusorian, but a more highly organized animal related to the radiates. He regards the sponges and acalephæ as having been evolved from a common ancestor, which he terms *Protascus.*

We note in the *Monthly Microscopical Journal* for May the completion of the excellent series of papers by Messrs. Dallinger and Drysdale, entitled "Researches into the Life History of the Monads." Five different forms of these have been thoroughly studied, and they name them respectively the *cercomonad*, the *springing monad*, the *uniflagellate*, the *biflagellate*, and the *calycine*, the latter so named from its pe-

culiar calyx-like form. The authors state that the complete detail in the development of these monads was only successfully compassed by the one twenty-fifth and one fiftieth of Powell and Lealand, with diameters ranging from 2500 to 5000. They express a complete distrust of all observations founded on successive "dips" in a quickly changing organic infusion, and put no faith in observations of this sort, and not conducted on the plan of keeping the same drop under continuous observation during all alleged transformations. From their own observations on these lowly forms they are constrained to say "that not the slightest countenance is given to the doctrine of heterogenesis. On the contrary, they find the life cycle of a monad to be as rigidly circumscribed within definite limits as that of a mollusk or a bird. The heating experiments uniformly proved that the spores resulting from sexual generation have a power of resistance to heat over the adult, which is greater in the proportion of eleven to six on the average—the very essence of the question of biogenesis *versus* abiogenesis—some of the spores resisting 88° Fahr. above the boiling point of water. This result agrees with the experiments of Dr. W. Roberts, and later of Huitzinga, who could not destroy the bacteria or their germs by boiling for half an hour under a heat of 230° Fahr.

In the proceedings of the Philadelphia Academy, April, 1875, we find a paper by Dr. Leidy upon a curious rhizopod, which he terms *Biomyxa vagans.* He compares it to the reticular pseudopods of a *Gromia* separated from the body. The creature moved actively, and assumed the most varied forms. This curious rhizopod had already been observed, especially in connection with the Diatomaceæ. When, in moving along the stems of conferva, it encounters a group of diatoms—synedra, *e. g.*—instantly the whole mass spreads out and envelops them, and for hours remains motionless, except the movement of the internal granules. A partial solution of the silica is effected in the process of digestion; for after some hours an enveloping case, partially silicious, and which has formed during the interval, inclosing both rhizopod and diatoms, is ruptured, and in one or more streams the branching mass escapes, leaving the silicious case quite perceptible, and the diatoms so firmly fused together that se-

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vere treatment with acids will not separate them. Professor Leidy considers it sufficiently distinct to represent a genus, and it is certainly a remarkable object. It was, no doubt, a case of encysting of this kind upon which Dr. Bastian, in his "Beginnings of Life," founds his assertion of the resolution of *Euglena* into diatoms.

A paper was recently read before the Quekett Microscopical Club, by Mr. W. F. Woods, on the relation of *Bucephalus* to the cockle. He states that, in contradistinction to the opinion of M. Lacaze-Duthiers, who has described it as a cercarian form of some unknown *Distoma*, that either, first, the *Bucephalus* is the larva of the cockle (and if not, it remains an interesting question for solution what is), or, second, the *Bucephalus* is a parasite; but if so, it does not render the cockle sterile, as asserted by Lacaze-Duthiers; and, third, the connection of the tube with the ovisacs, as established by presence of eggs in both, proves that it is not an independent sporocyst, but an organ of the cockle; while, fourth, if this connection be denied, the *Bucephalus* must still be developed from eggs seen in the tube.

In contradistinction of a third assertion by Lacaze-Duthiers, Dr. Wallich writes as follows in the *Lancet* (June 12) on the subject of nutrition of the protozoan. He states that for fifteen years he has stood alone in maintaining that the law of nutrition which prevails in the case of the higher orders of the animal kingdom, and constitutes the fundamental distinction between it and the vegetable kingdom, fails in the case of the simplest and humblest creatures; and he expresses a belief that the lower rhizopods provide for their nutrition and growth by eliminating from the medium in which they live the *inorganic* elements that enter into the composition of their protoplasm, and that there is no hard-and-fast line between the two extremes of the two great kingdoms, but a gradual transition and overlapping from both sides. The results of deep-sea explorations, and especially the examinations of the *Tuscarora* soundings, do not confirm this view; the vegetable growths, even at extremest depths, proceed *pari passu* with the animal, and we see as yet no reason why the same provision that holds good in the case of the higher and terrestrial organisms should not be extended to the humblest marine or aqueous forms.

Professor Leidy has recently called attention to the parasite that lives in the proboscis of the house-fly, a thread-worm —*Filaria muscæ*—first discovered by the well-known naturalist Mr. J. H. Carter in the house-fly of India. Dr. Leidy found it in numbers from one to three in about one fly in five. Dr. Diesing has referred the parasite to a new genus, with the name *Habronema muscæ.* The singular position in which the worm lives suggests that there are many unsuspected places in which we may have to search to find the parents or offspring of our own parasites.

In a communication to the French Academy in November last, M. Duval, calling attention to a former paper in the *Journal de l'Anatomie*, September, 1874, states that he has found a means of explaining both the doctrines of the panspermists and the heterogenists. The explanation lies simply in the statement that he has discovered that the various so-called minute organisms (such as ferments) are simply one and the same organism, which has the power of becoming differently developed. He asserts that he has proved by experiment that the transformation of yeasts is possible, and that the specificity of action of different ferments is a purely relative phenomenon, dependent rather upon the composition or the state of the media than upon the proper constitution of these same organisms.

For ten years after the publication of Ehrenberg's "Infusionsthierchen," it was supposed that the Rotifera were all hermaphrodites. In 1848 Mr. Brightwell discovered a rotifer with separate sexes in the genus *Asplanchna;* in 1850 Mr. Gosse discovered the male of another species of the same genus, and in 1854 Dr. Leydig that of a third. Two years later Mr. Gosse figured in the "Philosophical Transactions" the males of several species of *Brachionus*, *Polisarthra*, *Synchæta*, and *Sacculus.* More recently Dr. C. T. Hudson has discovered the male of *Pedalion mirum.* Previously to this discovery it will be noticed that the others belong all to one group—the free swimming rotifers; and this caused Professor Huxley to consider the *Rotifera as permanent forms of echinoderm larvæ*, and his argument was hard to answer, for it rested on the supposed monœcious character of some of the largest and most common rotifers—creatures constantly watched and studied in consequence of their great size and

beauty. The discovery of Mr. Hudson, especially of the male of *Lacinularia socialis*, weakens Mr. Huxley's argument considerably. And though it may possibly still be held desirable to rank the Rotifera among the Vermes, we can not reckon among the reasons their sexual resemblances to the echinoderms; and there is at least one, viz., *Pedalion*, which it seems impossible to class among the worms, for it has six hollow limbs worked by striated muscles, some of which pass freely through the cavity of the body.

II. BACTERIA.

Messrs. Dallinger and Drysdale, whose excellent researches on the life history of a monad have elicited universal commendation, have recently taken up the study of Bacteria. Using the new immersion, one-eighth of Powell and Lealand, an objective capable of resolving the striæ of *Amphipleura pellucida* into beads, as also the fine striæ of *Surirella gemma*, they find that *B. termo* is furnished at both ends with a flagellum, exquisitely delicate, and only to be discovered when in the proper position in regard to the light.

In an abstract of a paper by Dr. Hollis on "What is a Bacterium?" in the January number of the *Monthly Microscopical Journal*, the limitations we should place on the term Bacteria are summed up: 1. They strictly form part of the vegetable kingdom. 2. The name ought to be restricted to those minute rod-like hyaline bodies, *B. termo* and *B. lineolata* of Cohn, with a more or less rapid to-and-fro motion. 3. We must always associate the presence of true Bacteria (especially the *B. termo*) with putrefactive or analogous changes in organic liquids.

Development of Bacteria in Organic Tissues Protected from Air.—M. Servel recently read an interesting paper on this subject before the French Academy of Sciences. The first two experiments were upon Guinea-pigs; the live animals were decapitated so that the head fell at once into a chromic-acid bath. Examined six days after immersion, the outer parts were hard and preserved, but the cerebral parts were in manifest corruption, and the cerebral pulp, under the microscope, presented a large number of bacteria of all sizes. In these experiments the absence of air-germs was not sufficiently demonstrated, and M. Servel repeated them with the

livers and kidneys of dogs, killed for this purpose by femoral bleeding. To eliminate sources of error, and especially entrance of air by the wound, he placed a ligature at the level of the hilum of the liver and kidney to be experimented on, the organs were removed, preserving their envelope of connective tissue, and the ligature was used to suspend the organs in the bath. Examination some days after showed that the surface was hardened throughout, but the central parts were full of bacteria; the chromic acid at once arrested their movement. Hence he concludes: 1. That MM. Bechamp and Estor's demonstration of the production and evolution of bacteria in organic tissues protected from air-germs is quite exact. 2. That the effect produced by preservative agents is the death of microzymes, or molecular elements surviving in the organs.

III. THE CHALLENGER AND TUSCARORA SOUNDINGS.

Dr. Wyville Thompson says, in his report in the Proceedings of the Royal Society, No. 156, that in latitude 60° 52′ south, longitude 80° 20′ east, also 53° 55′ south, and 108° 35′ east, the sounding instrument came up filled with a very fine cream-colored paste, which scarcely effervesced with acid, and dried into a very light impalpable white powder; examined under the microscope, it was found to consist almost entirely of the frustules of diatoms, many broken, and some wonderfully perfect; with these were rods of a singular silicious organism, hollow, and, as subsequently obtained floating by means of a tow net, a little to the north of the Heard Islands, containing the characteristic endochrome of the diatoms. The tow net was at this time filled with a pale yellow gelatinous mass of diatom ooze, and Professor Thompson, considering the bottom Diatomaceæ as dropped from this belt of diatom ooze, as he terms it, and which was found somewhat farther southward, attributes the difference of position to the reflux of the Agulhas current. The existence of diatom ooze over vast surfaces of the Pacific is abundantly proved from the soundings of the *Tuscarora*. Many of these consist of diatoms only, and as they are not in the semi-fossil condition of those obtained by the *Challenger*, but still with endochrome within the frustules, and the ooze itself of a yellowish-green tint, it is but fair to conclude that ex-

tensive belts of these organisms are still living at great depths, and serving the purpose, precisely after the manner of land plants, of eliminating carbonic acid, appropriating the carbon and giving forth the oxygen.

One of the finest yields of diatomaceæ, principally *Coscinodiscus omphalanthus*, *C. concavus*, *Asterolampra Brookei*, *Rhizosolenia hebetata*, and *Triceratrum arcticum*, was from latitude 52° 11′ north and longitude 176° 48′ east, from a depth of 1681 fathoms. Another cast, latitude 43° 47′ north, longitude 150° 2′ east, from a depth of 4234 fathoms, consisted almost entirely of diatomaceæ, principally *Coscinodiscus* and *Biddulphia*.

Among other interesting results from examination of the deep-sea soundings of the *Tuscarora*, we may mention the occurrence of undoubted living foraminifera, not derived surface forms, at a depth of 2711 fathoms. At this depth, as might be expected from the large amount of carbonic acid, no calcareous organisms could exist, and none, except a stray *globigerina*, too recently dropped to be dissolved, were found; but there were multitudes of sandy *Lagenidæ*, some very large; also *Lituoldiæ* (especially *L. canariensis*, and various *Trochamminæ* and *Dentalinæ*, with polished sandy tests like *Trochammina*). But the most noteworthy fact was the occurrence of *Orbulina*, not with calcareous or sand-incrusted calcareous tests, but with shells wholly of sand grains, and perfect in shape, too large and heavy to have ever floated. The abundance and character of all these forms, along with which were numerous sand tubes and great numbers of *Acanthometrinæ*, *Thallassicollinæ*, and *Polycystinæ*, preclude the idea of dropped surface forms. In another sounding, of 108 fathoms, were fine specimens of *Lingulina*, and some transparent enough to show distinctly the early growth, a rapidly increasing spiral, which is masked entirely in the fully developed, and more or less sandy rectilineal tests of the matured form. At a depth of 1625 fathoms, specimens were found of the genus *Ellipsoidina* of Professor Seguenza, hitherto only known as fossil from the miocene marls around Messina.

In a paper read before the Royal Society, November 26, 1874, by Professor C. Wyville Thompson, the origin of the calcareous formation known as "globigerina ooze" is attributed to surface organisms, as advocated by the late Professor

Bailey, of West Point, and others; and in partial proof that all the organisms entering into its composition are dead, the statement was made that "there are never spines on the globigerinæ from the bottom, even in the shallowest water." This is a mistake, as the spinous globigerinæ were quite abundant in the soundings from the Gulf of Campeche made during the summer of 1874, during the cruise of the United States steamship *Fortune*, from depths of between 64 and 210 fathoms.

ETHNOLOGY.

Our summary of progress in *Anthropology* and *Ethnology* will embrace:

1. An account of prehistoric researches in various parts of the world.

2. A record of investigations among living tribes of men.

3. A synopsis of discussions upon general and special problems.

4. A report of improved apparatus of research; of expeditions and instructions to observers; of anthropological societies and sections of general societies, and their published Proceedings; of museums and notable private collections; of periodicals, wholly or in part devoted to anthropology; and of the bibliography of the subject since the publication of our last volume.

I. PREHISTORIC RESEARCHES.

America.—The Alaska Commercial Company has presented to the National Museum eight mummies from the cave of Kagamil, Aleutian Islands. They resemble those from Peru, being doubled up and wrapped in the finest furs and grass matting.

Alphonse L. Pinart publishes an account of his exploration of the cave of Aknanh, Island of Ounga.

Le Père Pétitot, in a long communication to the Paris Geographical Society, describes the stone and bone implements found in the Mackenzie River district.

Some of the most extensive and successful researches ever made in American archæology are being conducted by Mr. Paul Schumacher, under the auspices of the Smithsonian Institution, on the west coast of the United States from Oregon to the Santa Barbara Islands. Hundreds of skulls have been

exhumed, and the amount of mortars, pestles, stone implements of every sort, pottery, burial deposits, etc., is simply incredible. A partial report of his labors will be found in the Smithsonian Report for 1874. The finest specimens of his collection will be exhibited at the Centennial. Further reports on California will be found in the paper of A. S. Hudson, M.D., "On Shell-mounds in Oakland, California" (Proc. Cal. Acad., 1874), and that of Mr. L. G. Yates, on "Aboriginal Mounds in California" (Am. Assoc., 1875). The researches of Stephen Powers in Northern California, and of Rev. Stephen Bowers in Santa Barbara, are also to be noticed.

The government surveyors of the Great Interior Basin have been as fortunate as usual in discovering relics of ancient populations.

Messrs. Holmes and Jackson have examined a series of rock-shelter dwellings, towers, burial-places, etc., and have recovered a great number of inscriptions from the face of the cliffs in Southwestern Colorado and Northeastern Arizona, on the River San Juan and its tributaries. The most interesting of their discoveries in 1874 are described in Bancroft ("Native Races," Vol. IV., Chap. XI.). Their last summer's finds are graphically detailed in the *N. Y. Herald* letters.

Professor R. J. Farquharson read a paper before the American Association at Detroit on "Recent Mound Explorations at Davenport, Iowa." Mr. Henry Gilman gave an account of the ancient men of the great lakes, with especial reference to flattened tibiæ. In the Smithsonian Report for 1875 the same author will describe skull perforations from the same district, of which he has observed about twenty examples. The following communications were also made to the Detroit meeting: "On Mound Explorations in Kent County, Michigan," by Professor E. A. Strong and W. C. Coffinberry; "On Archæology in Wyoming," by F. B. Comstock; "On Ancient Structures of New Mexico," by E. D. Cope; "On Indian Mounds and Shell-heaps near Pensacola, Florida," by Dr. George Sternberg.

Dr. C. Schmidt read before the German Association at Munich a memoir on American mounds compared with remains of old mounds in Southern Germany. Mr. Joseph Wilcox describes in the Proceedings of the Academy of Natural Sciences of Philadelphia an ancient burial custom in Tennessee.

The State Archæological Association of Indiana held a meeting on September 29th and 30th, to take measures for preserving the monuments of the state. Other states of the Mississippi Valley are engaged in the same laudable work.

Dr. N. Joly has an article in *La Nature* (January 23, 1875) on "L'Homme Primitif Américain."

In *Revista de Antropologia*, Madrid, February and May, 1875, is an article entitled "De las Armas offensivas y defensivas de los Primitivos Americanos."

Mr. Hyde Clarke has just published, through Trübner & Co., in pamphlet form, his article in the *Journal of the Anthropological Institute* entitled "Researches in Prehistoric and Protohistoric Comparative Philology, Mythology, and Archæology in Connection with the Origin of Culture in America, and the Accad or Sumerian Families." The author attempts to utilize the latest investigations of cuneiform inscriptions in unveiling the mysteries of American colonization.

The eighth Annual Report of the Peabody Museum contains an account of the Swallow Collection, the Collection of Professor Wyman in Florida, and reports of smaller North American donations.

The "Congrés International des Américanistes" was held at Nancy from July 19th to 22d. The programme was as follows:

First Meeting.—History of Ancient America, and ante-Columbian relations with the Old World. President, M. Torres Caicedo, San Salvador.

Second Meeting.—Ethnology. President, Professor Hynes, Boston.

Third Meeting.—Language. President, Waldemar Schmidt, Copenhagen.

Fourth Meeting.—Archæology. President, Fr. von Hellwald.

The following gentlemen presented papers:

M. Gravier. The Dighton Rock inscription.

M. Foucheux. The Relation of the Buddhists with America at the commencement of our era.

M. Lucien Adam. The legend of Hoei-Chin, and the claims of Mexico to be the Fou-Sang of the voyagers.

The legends of the lost Atlantis, of Phœnician voyagers to our shores, and of Phœnician inscriptions, met with little fa-

vor. The opinion of M. Dally, that in studying American primitive history the purest scientific processes should be employed, met with general approval.

M. le Baron de Bretton, delegate of the King of Denmark, presented an important paper on the discoveries of the Northmen.

In the second meeting, the following gentlemen participated:

Dr. Paul Broca. On the deformed skulls of the Chibchas and other tribes.

M. L. Petitot. On the Southern origin of the Esquimaux.

M. Mader de Montjau. On the indigenes of Hayti.

M. Jules Ballet, of Guadaloupe. On the Caribs of the Antilles.

In the third meeting, papers were read by:

M. Pacheco Zigarro, of Cuzco. On the Quichua.

M. Leon de Rosny. On the systems of deciphering the Maya.

M. Julien Adam, for M. Julien Vinson. On the pretended analogy between the New World tongues and the Basque language.

In the fourth meeting the following gentlemen took part:

M. Oscar Comettant. Music in America before Columbus. "The Peruvian flute is sad, timid, and prophetic; and, after having presided over the magnificent fêtes of the Incas, serves to console their descendants in degradation and slavery."

M. Waldemar Schmidt. On sketching and other art manifestations among native Greenlanders.

The executor of the will of Mr. George Latimer has sent from Porto Rico to the Smithsonian Institution the magnificent prehistoric collection of that gentleman, embracing 36 sacrificial yokes (?), a large number of mammiform stones of various patterns, a beautiful collection of celts, besides a variety of other materials.

In *Scribner's Monthly* for August is an illustrated article on the "Stone Age of the Antilles."

Mr. Herbert Spencer's "Descriptive Sociology," Div. II., Pt. I., B, is devoted to Mexicans, Central Americans, Chibchas, and Peruvians.

Vol. I. of Pinart's "Bibliothèque de Linguistique et d'Ethnographie Américaines," is devoted to the "Lingua Chiapaneca."

Lopez Borregnero has published in Madrid this year his work entitled "Los Indios Caribes, Memorias Interessantes de Venezuela.'

Mr. Hutchinson continues his interesting researches among Peruvian antiquities. He objects to having them all ascribed to the Incas. He agrees with Mr. Baldwin that the original South Americans were the oldest people on the continent, and that "the mythical cradle of the Incas will be sought in the National Library at Madrid, instead of in the Lake of Titicaca, to which latter place it is assigned by the Hackluyt Society."

In the *Revue d'Anthropologie*, No. 1, 1875, M. Ber makes a communication on the prehistoric populations of Ancon, Peru, with an appendix by M. Topinard. Professor Bastian is now traveling in Peru and Ecuador, examining their antiquities.

Dr. Reiss, of Riobamba, Ecuador, sent to the German Anthropological Society, in 1874, some interesting remains of the times of the Incas. Professor Seebach at the same meeting gave an ethnographical scheme of the Central American tribes.

Professor Hartt, in his treatise on pottery, promises an extended work on Brazilian antiquities.

Francesco P. Moreno has published in Buenos Ayres, "Noticias sobre antiquidades de los Indios del tempo antérior á la Conquista de Buenos Ayres."

The most interesting prehistoric find from South America is the skeleton of a fœtus from Peru, presented to the museum of the Laboratory of Anthropology of Paris by Dr. Bourrie. Dr. Paul Broca has made a thorough examination of this specimen with reference to the pretended "os de l'Inca," or the uniform occurrence of a supernumerary bone in this race, similar to the intraparietal of some mammals. He concludes, "It is certain that the great majority of Peruvian skulls do not possess this intraparietal bone, but the phenomenon occurs often enough to render it probable that it occurs more frequently among the Peruvians than in any other race."

The whole subject of North American Archæology is reviewed in the fourth volume of Bancroft's "Native Races," embracing among other matters the latest researches of

Messrs. Holmes and Jackson among the rock-shelter structures, stone towers, etc., of Arizona and New Mexico.

Europe.—In the Belfast volume of the British Association (p. 116) is a most interesting abstract of Sir William Wilde's address before the Anthropological Department, on the subject of the early races who peopled Ireland in consecutive order, their remains still existing, and an inquiry as to what vestiges of these different waves of population remain to the present hour.

In discussing the names of the rivers and peoples in Ireland, Hyde Clarke, before the same meeting, called attention to the similarity of many of them with those of the civilized tribes of North America. This was not due to the Phœnician, but to the much earlier period of civilization called the Sumir and the Accad of Babylonia, when the world was of one official speech, and great monumental cities were raised by people speaking allied languages in Southern Europe, Asia Minor, Babylon, India, China, Peru, and Mexico.

Before the British Association this year the following papers on European Archæology were read:

Canon Rawlinson, "On the Ethnography of the Cymbri." The authority of Cæsar and Tacitus in favor of the Germanic origin of this ancient race was set aside for the belief in their affinity with the Celts. This elicited from Mr. Freeman a warm eulogy on the historians in question. Dr. Beddoe and the Rev. J. Earle supported the paper.

Professor Rolleston, "On the Long Barrow Period," which he divides into three epochs. In the earliest, the dead were buried in chambers or galleries so constructed as to admit of successive interments. In the next period the dead were buried unburned in cists. In the third, cremation was practiced.

W. Mortimer, "On the Crania of the Round Barrows of the Yorkshire Wolds."

W. Pengelly, F.R.S., "On the excavation of Kent's Cave," and Mr. R. H. Tiddeman on the "Victoria Cave." The president of the section, Dr. T. Wright, commenting on the reports, was of the opinion that no direct evidence had been found that man existed in the British Isles previously to the glacial period. Mr. Pengelly will deliver a course of

lectures, the coming season, before the Glasgow Lecture Association, on Kent's Cavern—its testimony to the antiquity of man.

Mr. Brooke Pennington (Dec. 8th, 1874) read a paper before the Anthropological Institute on the tumuli and stone circles near Castleton, in Derbyshire. He gave a full account of the explorations of the barrow of Eldon Hill, forty-nine feet in diameter, containing remains of man, horse, rat, and pieces of wrought antler. The Rev. S. Magens Mello also spoke of a bone-cave in Cresswell Crags, on the eastern border of Derbyshire.

In France the greatest activity prevails with reference to researches in definite localities, and concerning the strata of population successively inhabiting the different departments. In addition to the *Bulletin de la Société d'Anthropologie*, two able periodicals, *Revue d'Anthropologie*, and *Matériaux pour l'Histoire primitive et naturelle de l'Homme*, are devoted entirely to anthropological investigations.

Before the French Association, Dr. Lagneau read a long and scholarly memoir on the ethnogeny of the populations of the northwest of France, passing in review the different peoples concerned in the ancient and present occupation of the region between the sea, the Saone, and the Loire. In prehistoric times, some dolichocephalic skulls, and two kinds of brachycephalic skulls—the one kind small, the other large and voluminous—assert the existence of at least three distinct races. The author cited both classic authorities and modern researches to establish his conclusions; and from the discussion awakened we conclude this to be one of the most important papers read.

M. Chantre also read a report on excavations made by the Archæological Society of Charente. M. Philip Salmon gave a description of his discoveries at Grand None, commune of Vinneuf (Yonné). M. de Baye reported having extracted from the grottoes of Baye (Marne) 54 skulls: 28 of men, 24 of women, and 2 of children.

Parts XVI. and XVII. of "Reliquiæ Aquitanicæ" have appeared, the former containing:

Chapter XXIII. Observations on the birds whose bones have been found in the caves of the southwest of France, by Alphonse Milne-Edwards.

Chapter XXIV. Notes on objects of stone from the caves of Les Eyzies, valley of Vezere, Perigord, by Professor T. Rupert Jones.

Chapter XXV. (extending into Part XVII.). Fossil man from La Madelaine and Laugerie Basse, by E. T. Hamy:

"The human bones from La Madelaine, Laugerie Basse, Bruniquel, etc., have recently been compared with those of the rock shelter of Cro-Magnon, and, thanks to the exaggerated ethnic characters of the latter, a number of peculiarities of the second order, which at first escaped notice, have been recognized and appreciated. We have been able up to a certain point to classify the characters, the degree of the fixity of which has been brought out by all these comparisons, consequently to determine which are the constant features of a race, and which are individual variation, and the amount of the latter, and finally, with the aid of this determination, to commence the study of the extension of the ethnic group in space and time." Part XVII., containing the closing chapters and full indexes, finishes up the work.

The origin and spread of the Basques is eliciting a great deal of discussion in France and the rest of Europe. Dr. Paul Broca, in *Revue d'Anthropologie*, No. 1, 1875, has a long and interesting article on the subject. In the *Journal* of the Anthropological Institute, the Rev. Wentworth Webster reviews at length the article of Boyd Dawkins in the *Fortnightly* of September, 1874, on the same subject.

At the Geographical Exposition, Paris, a prehistoric chart of France was exhibited by M. Mortillet. The same author has completed a scheme of French early history.

The *Paleolithic Age* he divides into four epochs:

St. Acheul. (Almond-shaped flaked axe.) The oldest.

Moustier. (Flint arrow-heads and scrapers, bilateral flake.)

Solutré. (Bay-leaf shaped arrow-head, bilateral chipping.)

Madelaine. (Barbed bone arrow-heads and flint knives.)

The *Neolithic Age* has one epoch:

Robenhausen. (Polished stone axes, flint arrow-heads, serrate chipping.)

The *Bronze Age* has two epochs:

Morgien. (First appearance of bronze.)

Larnaudien. (Objects hammered out, greater variety and finish.)

The *Iron Age, Protohistoric Era*, has two periods—the *Tumulus* and the *Gallic*.

The *Tumulus Period* has one epoch:

Hallstattien. (First appearance of iron.)

The *Gallic Period* is called

Marnien: epoch of the Marne, Helvetian epoch, third Lacustrian epoch. (Appearance of money.)

The *Iron Age, Historic Era*, has two periods—the *Roman* and the *Merovingian*.

The *Roman Period* has two epochs:

Lugdunien. (Roman money and industry prevailing.)

Champdolien. (Decadence of art and industry.)

The *Merovingian Period* is called

Wabenien: epoch of Waben, Frank or Burgundian epoch, Helveto-Burgundian epoch, Germanic epoch. (Roman industry replaced by forms entirely new.)—"Matériaux," 1875, Aug., p. 373; and "Tableau Arch. de la Gaule," Paris, E. Leroux.

A communication made by Dr. Prunières, of Marvejols, before the meeting of the French Association for the Advancement of Science at Lille, treated of the curious artificial perforations common among the neolithic skulls of the Lozère. These perforations vary in the pieces exhibited from an inch to an inch and a quarter in diameter. Near the perforated skulls were found rings of cranial bone, which seemed to be designed as amulets. They were evidently worked with flint tools. The men of the polished stone age practiced trepanning; for if some of the skulls appear to have been perforated after death, others were treated during life, and the patients had lived for years afterward. One skull presented three perforations, made near each other upon a line fore and aft. There is no distinction of age, the excisions occurring upon infants as well as upon adults. The motive of this strange custom was either medical or superstitious. They probably attributed disease to supernatural agencies. The evil spirit escaped through the opening made by the sorcerer, who wrapped the operation in a shroud of mystery by preserving the detached piece as a precious relic. From the appearance of these facts reported by the learned archæologist of Lozère, he said that a new light had been shed upon the intellectual state of man in the polished stone age.

It explained his religious conceptions, and confirmed the discovery of the figure of a goddess in the caverns of Baye (Marne). M. Broca remarks that perforated skulls were found also at the last-named station. Among the skulls dug up by General Faidherbe were found two in the same condition. Dr. Chil, from the Canary Islands, said that perforated skulls had been found in the ancient burial-places of his country.

Attention was also called to an example from the grotto of Lorde, upon which M. Hamy and M. Chaplain-Duparc gave some interesting details. A similarly perforated or trepanned skull was found by Mr. E. G. Squier among some ancient Peruvian crania collected by him.—*Bull. Soc. d'Anthro.*, 1874, 2 fasc., pp. 185, 205, and 1875, p. 542, 555; *Comptes Rendus*, 1874, LXXIX.; *Pop. Sci. Monthly*, Sept., 1875, p. 607.

Before the French Association, 1875, M. Chauvet reported the same phenomenon in the tumuli of Charente. A discussion by Dr. Broca and others ensued. See also in Part II. of this paper under *Sanson*.

M. Choquet, in his excavations near Montereau (Seine et Marne), has discovered, in connection with pottery, vases, and polished flint hatchets, forty-four distal ends of humeri, which have the olecranian fosse piercing the bone similarly to those mentioned by Mr. Henry Gilman in the Michigan mounds.

M. E. Baudrimont has discovered in the dolmen of Font-Real (Aveyron) a fragment of the lower part of a tibia exhibiting an exostosis produced by a flint arrow-head driven in, not by the point, but by the barbs, and in such a position that the projector was either below or pursuing the subject. The difficulty of conceiving how an arrow could have been shot into such a position inclines M. Baudrimont to think that we have here an example of primitive surgery.

The subject of Swedish Archæology is described in the work of Oscar Montelius, entitled "Sur les tombeaux et la topographie de la Suede pendant l'age de la pierre."

C. Engelhardt ("Matériaux," 1875, liv. 1, p. 68) gives an account of a tumulus excavated by him in Laland, Denmark. In the same volume (page 350) is a *résumé* of archæological work done in Denmark since 1869.

We have also received the report of the Museum at Copenhagen, by Waldemar Schmidt, containing, among other matters, an illustrated account of some Porto Rico stone implements.

A new pile-dwelling was lately discovered at the Swiss hamlet of Vingelz, not far from Biel, where, at a depth of only about three or four feet below the surface, a platform was found resting upon piles, and composed of beams nearly a foot thick.

The most interesting prehistoric Swiss discovery is that of Dr. Scheuermann, of Basle, who called the attention of Professor Rutimeyer to the fact that, while observing the impression of plants in the lignite (Schieferkohle), he noticed a number of pointed sticks resembling in appearance the surrounding coal. These Professor Rutimeyer thought to be of the species *Abies excelsa*, and certainly showing evidence of human workmanship. He moreover regarded them as contemporaneous with the coal. This coal is not only overlaid with glacial drift, but at least in some places (Metzikon, etc.) its substratum is of an erratic nature. If the Professor's conclusions are correct, we have here evidences of human work contemporaneous with *Elephas antiquus*, *Rhinoceros murkii*, cave bear, and aurochs in an interglacial period.

The annual meeting of the German Anthropological Society was held at Munich from the 9th to the 11th of August. The most flattering reports were received with reference to the prehistoric charts of Germany, which when finished will enable us to draw up for that country a scheme of history similar to M. Mortillet's archæologic charts of Gaul. Professor Schaafhausen presented a report upon the expenses incurred in excavating at Klusenstein, the cave of Hönnethal, and Martin's cave near Letmath. Professor Virchow spoke of some peculiar forms of skulls from the islands of the Zuyder Zee, and of the exhaustive work of J. Wilhelm Sprengel on the skulls of the Neanderthal type. (Brunswick, Vieweg & Son, 1875.)

In the report of the association for 1874 is a paper by Herr Virchow on the areas of brachycephalic skulls in prehistoric and historic times in Germany. Dr. Much, at Munich, gave an account of archæological researches in 1874 among the old German habitations and forts in Lower

Austria, especially on the Donau and the March.—*Mittheil. der Anth. Ges. in Wien*, 1875, Nos. 2, 3, 6, 7.

Herr Eckers made a report on researches into the remains of the Celts in South Germany. "Philology and archæology testify to the presence of the Celts, but Celtic skulls are unknown among us. Cemeteries containing dolichocephalic Germans exist every where, while in the tumuli graves, especially in Schwarzwald, the brachycephalic skull prevails. Have the Germans in their immigration into their present abodes found a people whom they partly destroyed, but from whom the tumuli graves proceed?" The discussion of the Celt question was taken up by Virchow, Kollman, Schaafhausen, Desor, Lindenschmidt, Mehlis, Marggraf, and others. Virchow also made a communication on the dikes of defense in Posen.

Major Wurdinger gave a brief account of the prehistoric finds in Bavaria. "The Stone, Bronze, and Iron Ages are not sharply divided here. Near Rosering a stone celt was found with an iron sword. In a mound on the Salzach a stone hammer was found with bronze rings of the later Roman period. In the palafittes of Starnburger Lake, rude and polished stone implements predominate over bone and horn."

The following interesting papers have been read before the Anthropological Society of Vienna:

"Prehistoric Discoveries in Lower Austria in 1874," by Heinrich Graf Wurmbrand.

"Results of Palafitte Researches," by the same.

"On Microcephaly," by Dr. A. Zuckerkandl.

"Prehistoric Objects from Schüttenhofen (Bohemia)," by J. Woldrich.

"A Macrocephal Turkish Skull," by A. Weisbach.

"The Bone-cave of Thayngen, near Schaffhausen," by L. Rutimeyer (see *Annual Record*, 1874, p. cxxi.). Professor Merk has published an account of this, a translation of which by J. E. Lee is issued by Longmans & Co. The next annual meeting will be held at Jena.

A shell heap has been discovered near Athens, composed almost entirely of a species of murex, and of others furnishing coloring matter. It is therefore concluded that this is the site of an ancient manufactory of the celebrated Tyrian purple.

The *National Quarterly Review*, 1875, pt. iv., has an article on Prehistoric Greece.

The whole subject of the European Stone Age is comprehensively and ably presented by Dr. Charles Rau, of New York, in *Harper's Magazine* from April to September, 1875.

Africa.—Dr. Chil y Naranjo read a note before the French Association describing the superstitious practices of the ancient Canariens.

There is an account of old Egyptian culture in the light of modern researches in *Ausland* of March 9th, et seq., with profuse references to authorities.

Hyde Clarke read a paper before the British Association at Bristol on prehistoric culture in India and Africa.

Asia.—F. von Hellwald treats of the voyages of the Phœnicians in *Ausland*, January 4, 1875, et seq.

The surveys of the Palestine Exploration Fund have been pushed forward this season, and many sites have been identified. The party was attacked during the summer, and some of them wounded, including Lieutenant Conder.

The American Palestine Exploration Society have pushed their work forward on the east of the Jordan.

George Smith has again visited the Mesopotamian valley. He has written two volumes of the "Ancient History from the Monuments," and he has been able to recover from the fragments in the British Museum the legend of the building of the tower of Babel.

At the meeting of the Anthropological Institute, November 24, 1874, Mr. C. Colesworth read a communication describing the ruined towers of Palmyra, containing skulls and other human remains, which were examined and reported on by Professor Busk.

The volume of Monier Williams, entitled "Indian Wisdom" (London, 1875, 8vo), is the best work on the literature, religion, etc., of the ancient Hindoos for the general reader.

General Cunningham has issued from Calcutta his report of the Archæological Survey of India. James Burgess has also published (London, 1875, 4to) an Archæological Survey of Western India.

Polynesia.—Herbert Spencer's Descriptive Sociology (No.

3, Part I., A, Division I.) is devoted entirely to Types of the Lowest Races, Negrito Races, and Malayo-Polynesian Races.

II. ETHNOLOGY OF EXTANT RACES.

America.—M. Alphonse L. Pinart has published in Paris this year "Ethnologie de la Cote Nord Ouest de l'Amérique," and other pamphlets on the same subject. M. l'Abbé Petitot has a long and carefully prepared article (*Bull. Soc. de Geog.*, July, Aug., Sept.) on the geography of the Athabasca-Mackenzie, in which he gives an exhaustive account of the people, dividing them into Esquimaux, Algonquins, and Dénè-Dindjies; the last named—commonly called Athabascans, Chippewyans, or Tinnehs—are a large family of Indians inhabiting Western Alaska, Hudson Bay Territory, British Columbia, etc., back from the sea. The author also at the Congrés des Américanistes gave a most interesting account of his residence among the people as a missionary. He will publish, through E. Leroux, Paris, a "Dictionnaire de la Langue Dénè-Dindjie (Montagnais, Peaux de Lièvres, Loucheux)."

Mr. James G. Swan, under the auspices of the Smithsonian Institution and the Indian Bureau, will make an interesting collection from the northwest coast to be exhibited at the Centennial. The Rev. M. Eells has sent to the Smithsonian Institution a manuscript of 164 pages, minutely describing the Twamish Indians of Hood's Canal.

In the Proceedings of the California Academy for 1874, Mr. Stephen Powers has two papers, one on the California aborigines (392), another on aboriginal botany (373). In the same volume is an illustrated article on the "mesh knot" of the Port Simpson Indians, by George Davidson.

The Smithsonian Report for 1874 contains an interesting account of the burial of a squaw in San Bernardino, Cal., by W. M. King.

General H. B. Carrington gave an account before the British Association of the Indians of Dakota.

All lovers of American ethnology will hear with pleasure of Mr. Shea's continuation of American Linguistics. The new series will commence with "A Grammar and Dictionary of the Language of the Hidatsa (Gros Ventres)," by Washington Matthews, M.D., U.S.A.

Major J. W. Powell, in his report of the Explorations of the Colorado River of the West, gives some notes and illustrations of the ethnology of that district. His long acquaintance with the people, and their perfect confidence in him, make him one of the most reliable historians of their culture. He has a large collection of photographs of their principal personages, of men, women, and children, singly and in groups, engaged in their characteristic occupations. He has also contributed to the National Museum a fine collection of vessels, clothing, ornaments, implements, weapons, gambling apparatus, and art-work, many of which will grace the Centennial. The whole subject of aboriginal life within the United States will be fully represented on that occasion. A pamphlet of instructions has been sent to Indian agents and others, and materials are already coming in from every quarter, and of the most interesting character. It is also proposed to display the living tribes by a family of four or five individuals in a special reservation in the Philadelphia Park, with their own outfit of clothing, dwelling, implements, etc.

The massive work of Hubert Howe Bancroft on the "Native Races of the Pacific States," whose first volume was merely noticed last year, is now completed. The hearty thanks of all students of American ethnology are due to the author for the zeal and patience with which he has prosecuted his labor. We have no space for a summary of the contents of a work which in order to be appreciated must not only be read but carefully studied. The 160 pages of index is itself a remarkable production.

Dr. J. H. Trumbull delivered a long and scrupulously prepared address upon the "American Language" before the American Philological Association, Newport, July 13, 1875.

Das Ausland (November 9, 1874) has a carefully written article on the linguistic researches of Dr. Hermann Berendt in Central America.

Mr. Henry Hague has recently sent to the National Museum the instruments of a full band of music of the Tactic Indians, among them the marimba, so graphically described by Arthur Morelet.

Franz Keller, in his accounts of his tour on the Amazon and Madeira Rivers, describes the habit of eating clay prac-

ticed among the natives of the forests in their border. They are so addicted to it that the prospect of a speedy and miserable death does not deter them. The negroes who work the plantations are compelled to wear iron masks, and are allowed to take them off only under the strictest surveillance. Beasts (excepting the jaguar) and birds are affected with a similar appetite. Hunters take advantage of the fact by hiding on moonlight nights near one of these clay beds, called barrieros, to which the deer and swine come to eat earth, and the jaguar to secure his prey.

Charles Frederick Hartt, A.M., chief of the Brazilian geological survey, has published at Rio Janeiro "Amazonian Tortoise Myths;" among others, the old fable of the tortoise and the hare appears as the tortoise and the deer.

In *Bullet. Soc. d'Anthropologie* (Paris, 1874, 2e, p. 222) Abbé Durand has a paper on the Sambagues of Brazil. In the same number (p. 182) is a paper on the Apeicas.

The Hackluyt Society has published "The Captivity of Hans Stade, of Hesse, A.D. 1547–1555, among the wild tribes of Eastern Brazil," translated by Albert Fortal, Esq., of Rio Janeiro, and annotated by Richard F. Burton.

Mr. Robert Ellis is the author of a work entitled "Peruvia Scythica," the Quichua language of Peru, its derivation from Central Asia, with the American languages in general, and with the Turanian languages of the Old World, including the Basque, the Lycian, and the pre-Aryan language of Etruria (London, 1875, 8vo, 219 pp.).

Two individuals, Bartola and Maximo, who have been exhibited in Europe and America since 1850 under the name of Aztecs, having been presented recently to the Society of Anthropology, Paris, by M. Topinard, a most animated and exhaustive discussion ensued upon the descriptions which have been given of them by Owen and others, and of the subject of Microcephaly in general.—*Bull.*, 1875, p. 36.

Europe.—Dr. Beddoe, in the report of the Belfast Meeting of the British Association, has an abstract of his paper on the modern ethnological migrations in the British Isles.

Attention is again called to M. Lagneau's paper before the French Association, mentioned under a previous heading.

Herr Schaafhausen read before the German Anthropological Society at Munich a paper on the early migrations of

the Lapps, and Virchow also gave a *résumé* of the Lapp controversy. M. Venioukoff's essay, to be hereafter mentioned, treats of the same subject.

At the same meeting Virchow made a report of investigations concerning the color of the skin, hair, and eyes of the children in public schools. Scholars examined, 760,000; 66⅔ per cent. light-eyed, 33⅓ per cent. dark-eyed; 54 per cent. blonde-haired, 41 per cent. brown-haired, 5 per cent. black-haired; 85 per cent. light-skinned, 15 per cent. brunettes.

In the Göttingen section of the German Anthropological Society, Professor Benfey discussed the language and customs of the Gypsies. Dr. Kopernicki reports his researches on Bulgarian skulls in *Archiv* and *Journal* of the Anthropological Institute (Dec. 11, 1874).

Hyde Clarke read a paper on the Himalayan origin of the Magyar and Finn languages; and Dr. Sauerwein before the German Anthropological Association one on the Northern Hungarian peoples.

Africa.—At the International Geographical Congress, M. Bourgeot attempted to show the affinity between the North Africans and the Caribs. At the same meeting Conto Murisculchi-Erizzo presented some locks of Akka hair. The work of Dr. Gerhard Rohlfs, entitled "Quer durch Afrika," holds a prominent place among the ethnological works of the year.

M. Bastian made before the German Association at Munich a very interesting report of his journey to West Africa. See also "Die deutsche Expedition an der Loango-Küste," etc. (Jena, Vol. I., 1874; Vol. II., 1875), by the same author.

M. Achille Haffray sends to the *Bulletin de la Société de Geographie* (September, 1875) an account of his "Voyage en Abyssinie a Zanzibar et au pays des Ouanika." Dr. Berenger Feraud publishes in *Revue d'Anthropologie* (I., 1875) his study of the Peuls of Senegambia.

The Hottentots and peoples of South Africa are discussed in a communication made by A. Merensky before the Berlin Anthropological Society (*Ausland*, Nos. 34 and 35, 1875). Before the same meeting Herrn Bartells and Fritsch exhibited a Basuto boy from the Transvaal Republic. The geographical expeditions of Stanley and Cameron promise a rich harvest of ethnological information.

Asia.—Dr. Halevy communicates to *Ausland* (November 16, 1874) an account of his journey through the Redschran; and Dr. Paul Langerhaus reported to the German Anthropological Society (1874) a trip among the Syrian Bedouins. He secured a number of photographs and skull measurements from the noble tribes of Adwan, Abbad, and Abudis, differing so materially from the Syrian Fellahin.

Before the British Association, Dr. Leitner described an ethnological and linguistic tour of discovery through Dardistan, the chief result being to establish the existence of languages contemporary with the Sanskrit.

In the report of the Belfast Meeting of the British Association (1874) is an abstract of a paper by Fred. Drew, F.G.S., on the distribution of the races of man inhabiting the Jummir and Cashmere districts.

Sir Walter Elliott read a communication before the anthropological section at Bristol on the localities of the races forming the present populations of India. The Koragars, a leaf-wearing tribe on the west coast of India, were described by J. Walhouse before the Anthropological Institute, London.

In a very interesting communication upon the Negritos of India, before the International Geographical Congress, Dr. Hamy showed the presence of this race of oceanic Negroes of short stature on the Gangetic peninsula. With great erudition he proved that the Negritos ought to occupy a large space of this territory, and that they have been little by little dispersed and almost annihilated by their invaders. M. Quatrefages followed on the same theme, drawing attention to the isolated groups of Negritos as distinguished from the compact Papuans, pointing to the probability of their having been the ancient inhabitants, and to their dispersion by other races.

Herr Jagor reported to the German Anthropological Society his ethnological tour in India, in which he had been liberally patronized by the Prussian government. A table of the races of Northern India is given by Louis Rousselet.

Mr. Bertram Hartshorne read before the British Association at Bristol a paper of the most thrilling anthropological interest on the Weddas of Ceylon.

The Andamanese were the theme of a communication to

the Anthropological Institute, on January 12, 1875, by Mr. G. E. Dobson.

At the International Geographical Congress in Paris, two long and able papers were read, the one by M. Venioukoff upon the races of Asiatic Russia, the other by M. de Hujfalvy upon the migrations of the Ouralo-Altaic races. Both elicited considerable discussion, and may be regarded as among the most able presented to the Congress. On motion of M. Hujfalvy, the name Turanian was abandoned for Ouralo-Altaic, as applied to non-Aryan races of Europe and the peoples of Northern Asia.

An account of the Ainos was given to the German Anthropological Society (1874) by Herr Pomoli, who considers them the probable aborigines of Japan, reaching back to the cave-bear period.

Arthur Conner described before the Royal Geographical Society his journey to the interior of Formosa (Proc., Aug., 1875). The account of the Japanese expedition to Formosa has been published at Yeddo in English.

At the meeting of the Anthropological Society of Göttingen (July 17, 1875), Dr. Von Ihering gave an account of teeth mutilations, especially in Southeastern Asia.

Oceanica.—Lieutenant Crespigny read a paper before the Anthropological Institute (*Journal*, July, 1875) on the Milanows of Borneo. The same people are described by M. Miklucho-Maklay.

Captain John C. Lawson (Anth. Inst., June 22, 1875) gives an account of the Papuans. Virchow made a report on Papuan skulls before the German Anthropological Society, 1874.

Australian ethnology is represented by the communication of Mr. John Forrest to the Anthropological Institute (June 22, 1875) on "the Natives of Central and Western Australia." Volume X. of the "Transactions and Proceedings of the Royal Society of Victoria" contains a paper by H. G. Pain on the Decay of Aboriginal Art in Australia and Polynesia.

Before the British Association, Bristol, Rev. Wyatt Gill gave an account of the Maories of New Zealand. "The Transactions and Proceedings of the New Zealand Institute, 1875," contains the following ethnological papers: The Mythology and Traditions of the Maoris in New Zealand; Notes on an Ancient Native Burial-place near the Moa-bone Point;

Notes on the Moa-hunter Encampment; On the Identity of the Moa-hunters with the Present Maori Race; On Maori Traditions; On the Discovery of a Cut Stump of a Tree giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era.

Dr. Barnard Davis contributed to the Dutch Academy of Sciences an exceedingly valuable paper relative to the Tasmanians. Their almost entire extinction within the last few years makes their history a subject of painful interest.

Dr. Rolleston, in his opening address before the Anthropological Department of Section D, British Association, spoke in congratulatory terms of the work of Dr. Carl Meinicke, "Die Inseln des Stillen Oceans" (Leipsic, 1875), and the article of the Rev. J. W. Whitmee in the February number of *The Contemporary Review* (1873) on the Ethnography of Polynesia.

Rev. Wyatt Gill read a paper before the British Association, Bristol, on the Traditions of the Hervey Islanders.

In *La Nature* (February 15, 1875) is an article by Dr. E. Hamy, entitled "Les Polynésiens et leur Extinction." He also read a paper before the Royal Geographical Society (October 21, 1875) on the results of his researches on the geographical distribution of the human race in East Melanesia. On the subject of extinction compared with ancient times, see Professor Rolleston's address before mentioned. The depopulation of Fiji by the measles is one of the latest disasters of this class.

The artificial perforation of the skull among the South Sea Islanders is the subject of an article in the *Bulletin de la Société d'Anthropologie* (1874, p. 494), by A. Sanson.

The *Journal* of the Anthropological Institute (July 5, 1875) gives an abstract of Edwin Reed's abbreviated translation of Dr. Philippi's work on Easter Island, published in Santiago in 1873.

No. 3 of Herbert Spencer's "Descriptive Sociology" is devoted to Types of Lowest Races, Negrito and Malayo-Polynesian Races.

III. DISCUSSIONS OF PROBLEMS.

Anthropology is so dependent and so widely related that the discussions which arise relative to it are almost innu-

merable. They comprehend the deduction of almost all sciences. We can only indicate a few of them, and refer the reader to those publications where he will find them more fully treated.

Origin of Man.—The greatest interest is springing up with reference to Microcephaly in its relation to the origin of our race. Dr. Samuel Pozzi (*Rev. d'Anth.*, II., 1875), following up the investigations of Marshall (*Phil. Trans.*, Vol. 154, XV., p. 501), of Bradley (*Jour. of Anat. and Phys.*, 2d Ser., Vol. VI., p. 65), of Broadbent (*id.*, III., p. 218), of Jensen (*Archiv für Anth.*, IV.), of Vogt (*Mém. de l'Inst.*, Geneva, XI.), of Schule (*Archiv*, 1872, p. 432), and of Aeby (*Archiv*, 1874), gives a summary of investigations, and his own conclusions on the subject. We have further discussions before the French Association this year, elicited by a microcephal boy presented to the meeting by Dr. Laennec on behalf of Dr. Petit, of the Asylum at Nantes. Dr. Paul Topinard (*Bull. Soc. d'Anth.*, 1875, p. 36) makes a communication on the two microcephals Maximo and Bartola. In the same publication (II., p. 164) we have a paper on "L'Étude du cerveau des microcephales." On the same subject we would mention Haeckel's "Anthropogenie," reviewed in *Ausland* (March 15, 1875).

In *Nature* (December 17, 1875) is a very interesting article by E. B. Tylor on the relation of race to species, in which are applied the dotted diagrams of Mr. Francis Galton.

Chronology.—On the chronology of anthropology we would draw attention to Herr Graf Wurmbrandt's speech on the chronology of prehistoric discoveries before the German Anthropological Society in 1874, followed by a lively discussion; to Professor Lauth's essays in *Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, etc.* (August, September, November, December, 1874), "On the Definition of the Boundaries of the Prehistoric;" to the treatise of P. Cazalis de Fondouce ("Matériaux," 11 and 12, 1874) on the hiatus between Paleolithic and Neolithic Times; of Jacob Messikommer (*Ausland*, April 12, 1875) on the Antiquity of Man; to the discussion (*Bull. Soc. d'Anth.*, 1875, II., p. 170) upon the concurrence of bronze and stone implements in the cemetery of Carandra; to the paper of Fraas (Ger. Anth. Soc., 1874) on the Tertiary Man (see also *Correspondenz-Blatt*, 1875, p. 16); to that of G. de Mortillet (*Rev. d'Anth.*, 1875, I.) on prehis-

toric study among the orthodox; to the letters of Schliermann from the museums of Leyden, Copenhagen, Stockholm, Lubeck, Berlin, etc., in *Academy*, Nos. 171, 173, 174, 176, 179, 180; and to the work of James C. Southall on the "Recent Origin of Man."

Physical Anthropology.—Professor Rolleston, in his opening address before the Anthropological Department of the British Association, discussed the merits of Craniography in deciding the question of race.

On the subject of Macrobians, the article of Sir Duncan Gibb (*Journ. Anth. Inst.*, 1875, p. 804) is to be consulted.

The work of M. Quatrefages on the "Fossil Races of Men" is reviewed in the following publications: *Comptes Rendus*, January 11, 1875; *Ausland*, March 15, 1875; and *Revue Scientifique*, January 23, 1875.

Psychical Anthropology.—On this subject we would draw attention to Herbert Spencer on the Comparative Psychology of Man (Anth. Inst., June 22); C. Staniland Wake on the Origin of the Moral Idea (Brit. Ass. Rep., 1874, p. 158); and to Dr. Redner on the Psychological Discussion of Memory (*Munich Anth. Soc.*, Feb. 26, 1875).

Environment.—M. Elisée Reclus's great work, "La Terre et les Hommes," is appearing in monthly parts. This learned production will give the connections of geographical environment with the races of men who have inhabited the different parts of the earth.

Professor Marsh has brought out a new edition of his "Man and Nature."

A very interesting series of papers in *Ausland* (Jan. 4 to Feb. 1) is devoted to the contribution of plants and animals to Shemitic culture.

General.—The paper of W. D. Mackintosh on Anthropology, Sociology, and Nationality, before the British Association, and that of L. H. Morgan, before the American Association, on the Progress of Culture, are worthy of study.

Culture.—M. Pietrement, reviewing the treatise of M. Sanson, agrees with him that the bones found in great abundance at Solutré are the remains of horses killed in the chase. In this view he opposes M. Toussaint, who holds that the horse was domesticated, and slaughtered for food and in sacrifice.

J. S. Phéné, before the British Association, read a paper on

the Age of Colossi, etc., with reference to America; and in "Matériaux" (1875, p. 394) is an article from Frederick VII. of Denmark on the methods employed in constructing the so-called "Halls of Giants," or dolmens.

Before the British Association, August 27, Mr. C. O. Groom Napier read a paper on the "Localities whence tin and gold were found." P. de Cessac is the author of a work, "L'Ambre en France aux temps prehistoriques." F. W. Unger (Göttingen, *Proc. Anth. Soc.*, Pt. I.) has a paper on the origin and working of bronze in Europe. G. de Mortillet read one (Fr. Assoc., 1874) on the introduction of the working of bronze in the West ("Matériaux," p. 459). M. A. Bertrand (*Bull. Soc. d'Anth.*) read one on the Oriental origin of the working of copper, tin, silver, iron, lead, etc. Wibel (Germ. Anth. Soc., 1874) read an essay on the chemical analysis of bronze.

Professor Drechsler made a communication on the beginning of agriculture, before the Anthropological Society of Göttingen.

"Matériaux" (February and March, 1875) has reproduced some interesting old papers on "thunder-stones."

Professor Hartt has published at Rio Janeiro "Notes on the Manufactory of Pottery among Savage Races," with references to authorities. Perhaps the very best production on the subject.

Colonel A. Lane Fox favors us with the Third Part of his Catalogue on Early Modes of Navigation, tracing the development of ship-forms. On the same subject attention is called to "History of Modern Shipping and Ancient Commerce," by W. S. C. Lindsay.

Professor Hartt has an article in the January Number of *Popular Science Monthly* on the "Growth of the Idea of Ornament."

On the subject of language, we call especial attention to E. de Chossat on the classification of the Babylonian and Ninevite cuneiform characters; to Hyde Clarke (Brit. Ass., 1875) on a Community of Aboriginal Names of Weapons in Prehistoric Times; to Dr. A.W. Bikkers on the Anthropological Aspect of Linguistic Metaphor; to Professor Whitney on the Life and Growth of Language; and to Dr. Hermann Brunnhofer (*Ausland*, 1875, No. 31, p. 611) on the Voices of Animals in Primitive Human Speech.

On domestic culture the following references are valuable: Anfänge der Familie (*Ausland*, Feb. 1, 1875); Discussion between Sir J. Lubbock and L. H. Morgan on Systems of Consanguinity (*Nature*, June 3d and Aug. 9th); On McLennan's Theory of Primitive Marriage, by J. J. Murray (Rep. Brit. Ass., 1874).

The science of social and public life is discussed by Dr. H. K. von Günther, on the Practice of Mummifying the Dead (Munich Anth. Soc., April 13, 1875); by Sir Henry Maine, on the Early History of Institutions; by Dr. Bela Weiss, on the Primitive Forms of Property (*Ausland*, No. 29, 1875, p. 565).

Important discussions on ethics and religion are: "The Origin of the Moral Idea," by C. S. Wake (Anth. Inst., June 25, 1875); "The Degeneracy of Man," by Rev. Jos. Edkins (Rep. Brit. Assoc., 1874, p. 150); "Mythology," by J. Raines (Anth. Inst., June 25, 1875); "Rhabdomancy and Belomancy," by Miss A. W. Buckland (Brit. Assoc., 1875); "Cultur und Religion," by H. K. Hg. Delff (Gotha, Perthes, 1875); and "The Theistic Conception of the World," by the Rev. B. F. Cocker, D.D. (New York, Harper & Bros., 1875).

IV. THE INSTRUMENTALITIES OF RESEARCH.

Herr von Ihering made a report to the German Anthropological Society, 1874, on new craniometrical and craniographical apparatus. On the same subject is an article by A. H. Cohausen in *Archiv für Anthropologie*, 1875, Vol. II., and one by Paul Broca in *Bulletin de la Société d'Anthropologie*, 1875, pp. 337, 377.

The new code of symbols for archæological maps, drawn up by a committee of leading savants of Europe, was explained by Mr. John Evans before the British Association at Bristol, and by Ernest Chantre before the French Association ("Matériaux," liv. xi. Supplement, 1875).

The president, council, and fellows of the Royal Geographical Society have prepared a Manual of Arctic Geography and Ethnology. A similar manual has been published by the Board of Admiralty.

The Indian Bureau of the United States and the Smithsonian Institution have published a pamphlet of Ethnological Directions, and circulars to Indian Agents and special collectors for the Centennial Exposition.

Reports of the following meetings, at which anthropological subjects were discussed, have reached us:

American Association for the Advancement of Science, Detroit, Michigan, August 11–17.

The American Philological Association, Newport, July 13–15.

British Association at Bristol, August 25 to September 1.

French Association at Nantes, August 19.

The International Geographical Congress and Exposition at Paris, August 15.

Congrés International des Américanistes at Nancy, July 19–22.

The Archæological Congress of France, Chalons, August 23–28.

The German Anthropological Society at Munich, August 9–11.

At the American Association for the Advancement of Science it was resolved to invite the next Congress of Prehistoric Archæology to meet in the United States in 1876.

A notable event was the sale at auction of the entire library of Mr. Thomas W. Field, consisting wholly of Americanas.

The following is a list of journals devoted wholly or in part to anthropology:

AMERICA:
- Contributions to Knowledge, Annual Report, and Miscellaneous Collections of the Smithsonian Institution.
- Annual Report of the Peabody Museum of American Archæology and Ethnology.
- Journal of the American Ethnological Society.
- Transactions of the American Association for the Advancement of Science.
- Transactions of the American Philological Association.
- Journal of the American Oriental Society.
- Annual Report of the Indian Commissioner.
- American Journal of Science and Art, American Naturalist, Popular Science Monthly, N. Y. Tribune Extras, N. Y. Herald Letters from New Mexico and the Stanley Expedition, Harper's Magazine, and Scribner's Monthly.

EUROPE:

Journal of the Anthropological Institute of Great Britain and Ireland.
Archæologia, and Proceedings of the Society of Antiquaries.
Archæological Journal.
Journal of the Royal Asiatic Society of Great Britain, and Transactions of the Society of Biblical Archæology, Geographical Magazine, Nature, The Athenæum, and The Academy.

Transactions of the Imperial Society of Friends of Natural Science, Anthropology, and Ethnography, Moscow.

Proceedings of the Anthropological Society of Sweden, Stockholm.
Notice sur les Musées archéologiques et ethnographiques de Copenhagen.

Archiv für Anthropologie, und Correspondenz-Blatt der Deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte.
Zeitschrift für Ethnologie, und Verhandlungen der Berliner Anthropologischen Gesellschaft.
Mittheilungen aus dem Göttinger Anthropologischen Vereine.
Mittheilungen der Anthropologischen Gesellschaft in Wien.
Zeitschrift der Morgenländischen Gesellschaft.
Petermann's Mittheilungen, Gaea (the first quarter entirely devoted to prehistoric researches), Globus, Das Ausland.

Bulletin de la Société d'Anthropologie de Paris.
Matériaux pour l'Histoire Primitive et Naturelle de l'Homme.
Revue d'Anthropologie.
Indicat. de l'Archéologue et du Collectionneur.
Journal Asiatique.
Bulletin de la Société de Geographie de Paris.
La Nature, Le Tour du Monde, Revue Scientifique.

Bulletino di Paletnologia Italiana.
Archivio per l'Antropologia e la Etnologia, Organo della Societa Italiana di Antropologia e di Etnologia, Florence.

EUROPE: Revista de Antropologia, Organo oficial de la Sociedad Antropologica Española.

ASIA: Transactions of the Asiatic Society of Japan.
Asiatic Researches, Bengal.
Journal of the Royal Asiatic Society of Bombay and Ceylon.

OCEANICA: Transactions of the New Zealand Institute.

ZOOLOGY.

Zoological explorations have been carried on during the past year in connection with the various expeditions sent out to observe the transit of Venus. Of these the labors of the Rev. A. E. Eaton and Dr. Kidder, on Kurguelen Island, have brought out the most interesting results.

During the past year also the zoology of the voyages of the *Erebus* and *Terror*, which has been unfinished for twenty years, has been completed.

In this country the corps of naturalists gathered at the headquarters of the United States Fish Commission, located for the summer season at Wood's Hole, have produced good results; and the naturalists connected with Hayden's and also Wheeler's exploring parties have met with excellent success.

Dr. Dohrn's zoological station at Naples was formally inaugurated in April. This laboratory has been already used by a number of English, Dutch, German, Russian, and Italian naturalists, and valuable researches published. A Russian naturalist of distinction, Miclucho-Maclay, has founded a small zoological station near Singapore. While in this country the Anderson School of Natural History has been abandoned for want of funds, the idea of summer schools for science-teachers has taken root, and during the past summer a successful session was held at Peoria, Illinois, and another at Cleveland, Ohio, under the name of the "Kirtland Summer School of Natural History."

Several new journals of especial value have been started in Germany: one is the *Morphologisches Jahrbuch*, edited by Professor Gegenbaur, of Heidelberg, and the *Zeitschrift für Anatomie und Entwickelungs-Geschichte* (Journal of Anatomy and History of Development), edited by W. His and W. Braune, Professors of Anatomy at the University of Leipsic.

Among new text-books, Professor Carus's "Handbuch der Zoologie" is completed by the issue of the second part of the first volume, containing a part of the Vertebrates, and the *Mollusca* and *Molluscoida*. In this country two excellent smaller text-books have appeared, Professor Tenney's "Elements of Zoology," and Professor Morse's "First Book of Zoology." The "Arctic Manual" is full of new matter relating to the natural history of Greenland.

"Life-histories of Animals, including Man," is the title of an elementary manual of comparative embryology, by Dr. A. S. Packard, Jr. It is reprinted in part from the *American Naturalist*.

The most valuable aid to the working zoologist is the "Zoological Record," the volume for 1873 having appeared during 1875.

Professor Huxley has proposed a new classification of the Animal Kingdom, based on Haeckel's; while Giard, of France, has proposed some changes, the necessity of which future studies must determine. For example, he unites the annelides *Sagitta* and the *Rotifera* with the *Mollusca*. Dr. Dohrn has suggested classifying the ascidians with the true fishes, while Giard thinks that they should be placed near *Amphioxus* (the lancelet).

The year 1875 has been prolific in speculative essays resulting from embryological and histological studies in connection with the evolution hypothesis, guesses being published which it will take decades of work to prove or disprove.

Beginning now with the lowest forms of life, and ascending to the vertebrates, it is now thought by Professor Wyville Thompson that the bodies occurring in Bathybius, and also in Globigerina ooze, to which the names of "Coccoliths" and "Rhabdoliths" have been applied, are probably either algæ of a peculiar form, or else the reproductive gemmules or sporangia of some minute plant.

From observations made by different exploring parties, it seems to be a matter of fact that the *Radiolaria* or *Foraminifera*, as well as the diatoms, inhabit the ocean all the way to the bottom; *i. e.*, that all the calcareous shells forming the ooze at the bottom have not fallen down from the surface. Several new American rhizopods have been described by Professor Leidy.

Professor Allman has given in his anniversary address to the Linnæan Society a sketch of "Recent Progress in our Knowledge of the Ciliate Infusoria." The same thing in briefer space has been attempted by Dr. Packard in the *American Naturalist* for all the *Protozoa*, especial stress being laid on their modes of reproduction.

Further studies on the *Gregarinæ* have been made by A. Schneider. It is well known that these low *Protozoa* on maturing encyst themselves and break up into a number of spores (pseudonavicellæ and psorospermeæ). In two genera, *Gregarina* and *Stylorhynchus*, Schneider has found a special apparatus for the dissemination of these spores.

A detailed account of our North American sponges has been begun by Professor Hyatt, and it is now hoped that these neglected animals may be worked up. The first paper, on the North American *Poritidæ*, has an excellent plate, and contains references to certain foreign species. Mr. N. J. Carter has published a classification of the sponges, in which the orders and families, and groups within families (not genera and species, however), are characterized. The fresh-water *Spongilla* has been found by Mr. Sorby to contain constituents, such as varieties of chlorophyl and xanthophyll and lichnoxanthine, all of which occur in plants.

A gigantic hydroid polyp was dredged by the *Challenger* Expedition, measuring seven feet four inches high, and the crown of tentacles nine inches across from tip to tip of the expanded (non-retractile) tentacles. It occurred at the depth of 1875 fathoms, on the 17th of June, in latitude 34° 37′ north and longitude 140° 32′ west, and again, four feet in height, at the enormous depth of four statute miles, on the 5th of July, in latitude 37° 41′ north and longitude 177° 4′ west. The stem is enormously extensile, of a pale pink color. It is either a species of *Monocaulus* or an allied form. The proximal range of tentacles number about a hundred, and these are about four inches long, and almost transparent in life. The ovisacs are in close tufts of a maroon color, just at the base of the proximal tentacles. "The walls of the body-cavity," writes Professor Wyville Thompson, "were yellowish, and seemed to contain some vertical rolls of granular matter, and the hypostome terminates in a fringe of about forty-eight or fifty extensile tentacles around the

mouth." Professor Allman adds "that the enormous depths from which this colossal hydroid has been brought up should favor the development of gigantic representatives of the diminutive forms of shallower zones, and that in the tenants of these sunless regions of the sea we should find color not less vivid than that of their light-loving relatives, are facts full of significance." It is also to be noticed that the old idea of pressure at great depths of the sea is entirely incorrect, as this animal is soft and jelly-like as in the *Corymorpha* of shoal water. No deep-water hydroid polyps, as Allman remarks, produces medusæ, not being able to endure, "either before liberation from their parent hydroid, or for a period however short in their free state, the darkness and pressure and other conditions to which the dwellers in the deep are exposed."

More light has been thrown on the distribution and younger stages of the gigantic polyps *Umbellularia* by Dr. Willemoes-Suhm of the *Challenger* party. In the Antarctic Sea it has occurred as low down as 2600 fathoms.

The growth of the common coral, *Madrepora cervicornis?* in the Florida Keys is estimated by Professor Joseph Le Conte to be not more than three and a half to four inches per annum.

Little has been done in the Echinoderms, except by Professor Carpenter, who from his examination of the nervous and generative systems of *Comatula*, thinks that we should be justified in removing the Crinoids much farther from the rest of the Echinoderms than before. In fact, he thinks they have little in common beyond the calcareous network of the skeleton. To show how abundantly these crinoids may occur, Dr. Carpenter states that he had learned from a trustworthy observer that after a recent hurricane in the West Indies a vast number of *Pentacrini* had strewed the shore of Barbadoes, in all stages of growth, from one inch to eighteen inches in length; but unfortunately no naturalist was at hand to reap the rich harvest.

Further studies on the embryology of the *Mollusca* have been made by M. Giard, Ussow, and Lankester. The two latter have published their observations on the Cephalopods, while the researches of Giard were made on *Lamellaria perspicua*, a gastropod. The development of *Lamellaria* requires

two or three weeks, the eggs being laid in February and March. The embryo passes through an invaginate-gastrula condition, as in certain nudibranch mollusks (*Dendronotus* and *Goniodoris*). The first embryonic, deciduous shell is of a nautiloid form, and presents two dorsal and two lateral keels, like the shell of *Atlanta*. The second shell is more simple, like that of *Carinaria*, or of the embryos of the Nudibranches. Giard claims that they have the same relations to each other, and the same relative signification as the nauplian cuticle of the embryos of the Cirripedes and the carapace of the Archizœa inclosed under that cuticle. He does not think that the second shell is the origin of the calcareous shell of the adult *Lamellaria*.

A beautiful memoir on the early stages of the Pteropods and Heteropods, with admirable illustrations, has been published by Fol in Lacaze-Duthiers's "Archives."

The life-history of certain mollusks, abstracted from the works mostly of European observers, has been given by Dr. Packard in the *American Naturalist*. Of the mode of development of the oyster we have much new information by Salensky (1874) and Gerbe (1875). It appears that while some lamellibranch mollusks, such as the Unio, are bisexual, the oyster is hermaphroditic. The eggs, which are yellow, after leaving the ovary are retained among the gills. A single oyster may lay 2,000,000 eggs. The spawning time of the oyster in Europe is from June to September. During their development the eggs are inclosed in a creamy slime, growing darker as the "spat" (the term applied to the young oyster) develops.

The course of development is this: After the segmentation of the yolk, the germ divides into a clear peripheral layer, and an opaque inner layer containing the yolk, and representing the inner germinal layer. A few filaments or large cilia arise on what is to form the "velum," or the future head. The shell then begins to grow out at what is destined to be the posterior end of the germ, and before the digestive cavity arises. At this stage the two-layered germ is said by Salensky to represent the "planula" of the sponge. The digestive cavity is next formed ("gastrula" stage), and the anus appears just behind the mouth, the alimentary canal being bent at right angles. Meanwhile the

shell has grown enough to cover half the embryo, which is now in the so-called veliger state, the velum being composed of two ciliated lobes in front of the mouth-opening. The young oyster, as figured by Salensky, is directly comparable with the "veliger" or larva of the Cardium or cockle-shell. Soon the shell covers the entire larva, only the ciliated velum projecting out of an anterior end from between the shells. In this stage the larval oyster leaves the mother, and swims around in the water, the cilia of the velum keeping up a lively rotary motion. In this state Lacaze-Duthiers observed it for forty-three days without any striking change in form, except that the velum increased in size, and the auditory vesicle appeared, containing several otoliths, which kept up a rapid motion. But still the gills and heart were wanting. Of its further early history we know but little, except that it becomes fastened to some rock and is incapable of motion. The oyster is said, by the appearance of its shell, to be three years in attaining its full growth, but this statement needs confirmation. M. Gerbe has during the past year, according to *La Revue Scientifique*, cleared up some obscure points in the development of oysters, but what they are is not stated.

The development of a gigantic cuttle-fish, of an unknown species, has been worked out by Grenacher. The mass of eggs was thirty inches long. After segmentation of the yolk, unlike other cuttle-fishes known, the embryo assumes a spherical form, with a band of cilia, and is thus like the ciliated embryos of certain lower mollusks. This spherical stage is also remarkable for the early appearance of the mantle, with the contractile pigment-cells (chromatophores). The embryo soon elongates, the mantle grows, the eyes and arms bud out, and the form of the adult is rapidly sketched out.

Professor Hyatt has continued his studies on the Ammonites, having described new forms of Jurassic and cretaceous Ammonites collected in South America by Professors J. Orton and C. F. Hartt; and in another paper remarks on two new genera, *Agassiceras* and *Oxynoticeras*. In a memoir on the "Biological Relations of the Jurassic Ammonites," in course of preparation, but of which an abstract has been published, he traces the history of the evolution of the order

of Ammonoids, showing that the characteristics of the first three stages of the embryo were inherited from a very early period. These were, first, the sac-like shell of the embryo, containing the equally sac-like beginning of the siphon; second, the beginning of the true shell or apex, with its nautilus-like septum and peculiar nautilus-like umbilicus; third, the depressed and goniatite-like continuation of the form of the shell, with its accompanying goniatitic septa. These, of course, represent only their most advanced stage in the Ammonites proper of the Jura and Trias; they are, when first observed in the Silurian and Devonian, exceedingly variable in the length of the periods and other important characteristics, even between the varieties of different species. They become invariable in the young as embryonic characteristics only after the lapse of time represented by the Silurian, Devonian, and Carboniferous periods. This variability in the same species in the Silurian shows how recently they were inherited, and their invariability in every individual of the Jurassic shows the results of the long ages of inheritance through which the group has passed between that period and the Silurian epoch.

A number of descriptive papers appear in the Proceedings of the Zoological Society of London, and the German and French conchological journals. Among these, Beddome's "Descriptions of some new Operculated Land-Shells from Southern India and Ceylon," Mr. Guppy's notes on West Indian shells, and descriptions of new shells from Queensland, by Mr. Brazier, are noteworthy; while in this country the report on the mollusca of Hayden's Survey of the Territories, by Mr. E. Ingersoll, gives new information relating to the distribution of land-shells in Colorado. It seems that no land-shells were found on the eastern slope of the Rocky Mountains (though they do exist there). Altitude seemed to have little influence upon their range so long as other favorable conditions were present. The number of species which occurred was very small, owing to the dryness of the country. The *Pupæ* were perhaps the most common forms, increasing southward, while specimens of *Vertigo Californica* and *Pupilla alticola* were numerous every where in the mountains as high up as timber grows.

Our knowledge of the lower worms has been advanced by

the papers, finely illustrated, of Mr. MacIntosh, upon the structure of the Nemertian worms, while his work on the worms of Great Britain has been issued by the Ray Society.

Dr. Habrecht has described a number of new genera and species of these worms, and drawn attention to the minute structure of the nerve-ganglia. Hæmoglobin was detected by means of the spectroscope in the nerve-tissue of two species of *Meckelia* and in true red blood-disks of *Drepanophorus*. He has also noticed the formation of an invaginate gastrula in the early stages of *Borlasia olivacea*.

In last year's report we noticed the work of M. Villot on the structure and development of the Hair-worm (*Gordius*). He finds that the young *Gordius aquaticus* first makes its way into insect larvæ, such as *Chironomus*, and becomes encysted; after which it finds its way with its host into the alimentary canal of fishes, where it is again encysted. It escapes from this position in the spring.

Further researches on the ascidians by Ussow bring him to the conclusion that the Tunicates are not Mollusca. "Even," he says, "without taking into consideration the modes of embryonal development, a comparison of the plan of structure of the different mollusca with that of the Tunicata suffices to refer the latter with more propriety to the Vermes. The simple cardiac tube, the absence of the œsophageal ganglia and their commissure, the complete absence of the foot, the curvatures of the intestinal canal directed toward the heart, the existence of the outer mantle, and the peculiarities of its structure, mode of formation, and chemical constitution, the variability in the direction of the contractions of the cardiac tube, etc., all draw a more or less sharp boundary-line between the Tunicata and the Mollusca. The Tunicata approach most closely to the Bryozoa." On the other hand, he points out important characters in which the Tunicates approach the worms; while from the presence of a *chorda dorsalis*, the type of development of the central nervous system, and the relation of the alimentary tube to the bronchial sac, the Tunicata are related to the Vertebrata. Ussow goes so far as to adopt Oscar Schmidt's view, according to which the Tunicates form a special class of *Protovertebrata*.

From his study of the curious worm *Sagitta* M. Giard supports the prevalent view that it is a worm standing nearer the annelids than any other animals. In his essay he notes the characters these animals share with others leading a pelagic life, which are as follows:

1. An extreme transparency of all the tissues, which renders the animal completely invisible, and enables it to escape easily from its enemies. We observe it in the *Noctilucæ*, the *Siphonophora*, the *Medusæ*, the *Ctenophora*, the Heteropod and Pteropod mollusks, the *Salpæ* and *Pyrosomata*; in *Sagitta*, *Tomopteris*, and *Alciope*, and, lastly, in the *Leptocephali*, among fishes.

2. The unusual development of certain organs of sense, especially the eyes, and sometimes the auditory apparatus, as in the Medusæ and the *Appendicularia*, and in *Mysis*.

3. The small size of the digestive tube.

4. A considerable development of the organs of generation, and great fecundity.

5. A great number of pelagic animals present the phenomena of phosphorescence, such as the *Noctilucæ*, many *Medusæ*, the *Pyrosomata*, and *Phyllirhoë bucephala*. This phosphorescence, which is manifested especially when the animals are excited or alarmed, no doubt acts as a protection, and stops the pursuit of some enemies.

6. Their social life, as many of them swim in large masses.

M. Villot has made some observations on the migrations and transformations of certain marine parasitic Trematodes. Two very different Distomæ live in the intestine of the sea-lark, a kind of plover. One is *Distoma leptosomum*, and the other *D. brachysomum*. These two parasites are found in the larval state, still encysted, in the gizzard of the sea-lark; in the small intestine they are further developed, and when they arrive in the rectum they have acquired their adult size, and laid their eggs, which are ready to be expelled. As to the tadpole-like young (cercariæ) of these Distomas, those of *D. brachysomum* become encysted in small isopod crustaceans of the genus *Anthura*; while those of *D. leptosomum* are encysted in a small mollusk—*Scrobicularia tenuis*. The crustacean and mollusk both serve as food for the sea-lark. Professor J. Leidy notices some parasitic worms in the Proceedings of the Academy of Natural Sciences at

Philadelphia, while the anatomy of *Tænia mediocanellata*—a tape-worm more common in Europe than *T. solium*—is discussed by Dr. Welch in the *Quarterly Journal of Microscopical Science*.

A synopsis of North American fresh-water leeches, with descriptions of some new species, with figures, has been prepared by Professor A. E. Verrill for the Report of the United States Commissioner of Fish and Fisheries.

The *Crustacea* have been studied anatomically by Claus, in an illustrated essay on the higher Copepoda, in Siebold and Kolliker's *Zeitschrift*. The early condition of the nervous system of the king-crab (*Limulus*) has been described by Dr. A. S. Packard. Instead of the cephalothoracic ganglia being united to form a ring around the œsophagus, they are in the larva separate, five pairs of large ganglia corresponding to the five anterior pairs of limbs. The brain of the king-crab differs remarkably from that of the normal crustacea—*i. e.*, the lobster and crab—in sending off no antennal nerves, but only two pairs of optic nerves, there being, in fact, no antennæ in *Limulus*. While there is a general analogy in the form of the anterior portion of the nervous chord of *Limulus* to that of the spiders and scorpions, it does not prove that the king-crab is an arachnid, for there are other remarkable differences that forbid our placing the king-crab among the arachnids, and they should be regarded as very aberrant crustacea. Packard also described certain organs in *Limulus* as probably renal in their nature, and perhaps homologous with the green glands of the normal crustacea.

Additional facts regarding the metamorphoses of the spiny lobster (Palinurus) of the Mediterranean have been discovered by Gerbe. By his study of the Phyllosoma, or larva state of the Palinurus, he concludes that in the higher crustacea the peripheral portion of the arterial system very slowly arises, and during the early stage of the change the bloodvessels ramify among the tissues like the roots of a plant.

In descriptive crustaceology we have a "Synopsis of the Higher Fresh-Water Crustacea of the Northern United States," by Professor S. I. Smith, containing full descriptions of a number of interesting forms, including *Palæmon*

ohionis, a shrimp used for food in Indiana, and another shrimp—*Palæmonetes exilipes* of Stimpson—which occurs in Lake Erie as well as South Carolina and the fresh-water streams of Florida. The most remarkable shrimp-like form, however, is the *Mysis relicta*, first described by Lovén, from the inland lakes of Sweden. It occurs at various depths in Lakes Superior and Michigan, where it forms a large part of the food of the whitefish.

This Mysis is so closely allied to the *Mysis oculata* of the northern and arctic seas, being regarded by some as a simple variety, that its occurrence in these lakes so far from the sea is, as Smith states, a fact of peculiar interest, which goes far toward proving the marine origin of a part of the fauna of our great lakes. Dr. Stimpson believed that the great lakes had in recent (Quaternary) times been isolated from the sea by a rise of land. Very probably, at the time when the sea had access to these basins, the communication was somewhat narrow and deep, and the influx of fresh water from the surrounding country was sufficient to occupy entirely the upper stratum, while the heavier sea-water remained at the bottom.

After the basin had become separated from the ocean by the rise of the land, the bottom water must have become fresh by diffusion very slowly to allow of the gradual adaptation of the crustaceans to the change of element." Professor Smith adds that at the time Lake Ontario was a part of the great St. Lawrence valley sea, there was, very likely, no insuperable barrier in the Niagara River to the upward migration of active swimming animals like *Mysis*, and some of the inhabitants of the upper lakes may have reached their present homes by this route during the northern movement of the fauna at the close of the Quaternary epoch. "On the other hand, *Mysis relicta*, although originally derived from the strictly marine species *M. oculata*, may have existed long enough to have had the same history as some of the strictly fresh-water species, known to be common to Northern America and Northern Europe, since it has much the same geographical distribution." Other crustacea are mentioned in Professor Smith's "Sketch of the Invertebrate Fauna of Lake Superior," in the same report.

The habits of the blind crawfish of the Mammoth Cave have

been studied by Mr. F. W. Putnam. It takes almost no food, though the eyed species (*Cambarus Bartoni*) readily eats any food offered to it. On being startled, the blind species darts backward, extending its antennæ, and stands as if on the alert for danger. Milk-white specimens, on changing their skins, were afterward of the same color. It did not change its color after shedding its shell twice, or after living in full light of day, and often for hours in the sunshine, over five months. On April 20 the same specimen cast its shell for the second time, within three months of the time it last moulted. During this period it did not feed more than three or four times, and then only ate sparingly.

From observations made on the reproduction of lost parts in the blind crawfish, it appears that the parts, such as the legs and antennæ, are not reproduced in perfection after one moult, but that each time the shell is cast they are more nearly perfect than before. In the instance observed it required three moultings before the great claw attained nearly its full size, while an additional moult is necessary to perfect the limb. The posterior legs, on the contrary, are perfected in two moultings, and, in the case observed, in about five months from the time they were lost. The antennæ are reproduced more rapidly, and approach their full size in one moulting. During the five months the animal was in confinement it did not increase in size. Extremes of temperature did not affect the blind crawfish, as several specimens were kept without harm for several days in a heated room, and were exposed for weeks to such intense cold that the water in the jars was frozen.

A number of new North American sow-bugs, or *Oniscida*, are described by Stuxberg in the Proceedings of the Royal Swedish Academy. The same author describes in the "Annals and Magazine of Natural History" a number of new forms of *Lithobius* (a small centipede) from California and Mexico.

The studies of the Russian zoologist Metschnikoff on the embryology of the thousand-legs (or chilognathic Myriapods) have been supplemented by a beautiful memoir on the early history of *Geophilus*, a long, slender form allied to the centipedes (*Chilopoda*). In this form, as in other Myriapods, the yolk undergoes total segmentation, and the primitive band

surrounds one half of the yolk. In the next stage observed the antennæ and three pairs of jaws are developed (only two in the thousand-legs). In a succeeding stage the primitive band is much longer than before, and the head and tail approach nearer to each other, while there are now from forty-four to forty-six body-segments, most of them bearing rudimentary appendages, though there are none as yet on the end of the body. In a succeeding stage the head is much larger, the body longer and curved over the yolk, while the egg-shell breaker is situated on the second maxillæ. In a following stage the body is still more elongated and the joints of the antennæ appear. The embryo now slips out of the split shell, the body being very long and cylindrical, not yet flattened as in the adult animal.

The young Geophilus, and probably nearly all the centipedes, undergoes no metamorphosis, being born with nearly the full number of feet, while the young thousand-legs or millepede has but three pairs when hatched. We now have, thanks to Metschnikoff's other papers on the development of the Chelifer and Scorpion, and to the researches of other observers, quite full information regarding the life-histories of the tracheate Arthropods, or insects.

Unusual activity has been shown by students of the spiders both in Europe and this country. The writings of Hentz have been collected and republished by the Boston Society of Natural History, containing the text and plates of his papers in the memoirs of that society, with the addition of several excellent plates drawn by Mr. J. H. Emerton, with additional notes by him. A number of new species of spiders from Southern Europe and North America, belonging to the genus *Erigone*, are described by the Rev. O. P. Cambridge. Dr. Thorell has described a number of new forms from New Caledonia, Madagascar, and Reunion Islands. It appears that the *Nephila edulis* Vinson, of New Caledonia, a large spider allied to our *Nephila plumipes*, whose habits have been studied by Professor Wilder, is used by the natives as an article of food, while in Madagascar *Nephila Madagascariensis* Vinson, is also eaten, "en l'accommodant avec de l'huile ou de la graisse" (see Vinson, "Voyage à Madagascar," p. 126). He also gives some notes on venomous spiders. The so-called venomous spider of Madagascar, called

by the natives "foka" or "fook," is thought by Vinson to be probably harmless. Allusion is made by Thorell to the supposed poisonous nature of the *Lathrodectus Curacaviensis* of Curaçoa, South America. It is a congener of the poisonous Lathrodectus of Southern Europe and the Southern United States.

He has also published in the Proceedings of the Boston Society of Natural History a descriptive account of the spiders of Labrador, based on specimens collected by Dr. A. S. Packard, Jr.

The spiders inhabiting the caves of Kentucky and adjoining states have been studied by Messrs. Packard and Emerton, the latter affording descriptions and drawings of these interesting forms, some of which are blind, or with defective eyesight, and all more or less bleached. The two largest and consequently most ancient caves, Mammoth and Wyandotte, and in which the physical environment of the species is most unvarying, have but one species each. In the smaller caverns of Carter County, Kentucky, and the two Weyer's caves, the number of species and variation in the individuals are greater than in the previously mentioned caves. In each set of caves (Carter's and Weyer's) there are three species, to one in Mammoth and Wyandotte caves. What constitutes the food of these diminutive, weak, sedentary spiders it is difficult to conjecture, unless it be certain minute delicate mites or young Poduras. They spin no web, except some of the spiders of Weyer's Cave. The small flies (*Sciara* and *Chironomus*) are too large and bulky to be captured by them. The probable insufficiency of food, as well as light, may account for their small size and feeble reproductive powers. Mr. Emerton reports six species of cave spiders, all undescribed except one.

A few mites are known to inhabit the sea; the British species have recently been described and figured by Mr. G. S. Brady. Eleven species are now known to inhabit the coast of Great Britain, a number of which were obtained by the dredge, while one form (*Halarachne halichœri*) is parasitic in the posterior nares of a seal (*Halichœrus gryphus*).

Coming now to the winged insects, we can not say that much has been done during 1875 in the study of their development or anatomy. Unfortunately the mass of new species

is so great, and the insect-fauna of the earth, even of the older portions of the globe, as, for example, the older United States, is so little known, that students are still, and will be for years, busied with the merely preliminary work of descriptive entomology.

As a contribution to animal psychology, Lubbock's second paper on Bees, Wasps, and Ants claims notice. The merit of this tract is that a daily journal of the doings of individual insects is given, from which the reader may judge as to the correctness of the author's conclusions. He enumerates a number of facts showing that "some bees, at any rate, do not communicate with their sisters, even if they find an untenanted comb full of honey, which to them would be a perfect Eldorado." So far from having been able to discover any evidence of affection among them, "they appear to be thoroughly callous and utterly indifferent to one another." Their alleged devotion to the queen is "of the most limited character." That bees can distinguish scents is certain. While acknowledging the truth of Langstroth's statement that the bees of one hive know each other, he thinks it is by the sense of smell, and not by an act of the intellect. Bees differ as to the facility with which they find their way about. He then says, if "bees are to be credited with any moral feelings at all, I fear the experience of all bee-keepers shows that they have no conscientious scruples about robbing their weaker brethren." Regarding the industry of ants, he gives quite full statistics. He then gives some interesting experiments showing that ants communicate news to each other.

Frequent reference is made by Lubbock to Forel's new work, "Les Fourmis de la Suisse," a quarto work of 455 pages, with two plates, published at Zurich in 1874. As this is the most important work on insects of the last two years, we translate an abstract of its contents given by Blanchard in *La Revue Scientifique.* The work is worthy to succeed that of the author's fellow-countryman, Pierre Hüber. After describing the species, the author considers the relations between the peculiarities of structure and the adaptation for work or war. The descriptions are followed by anatomical and physiological studies of different organs, accompanied by interesting remarks concerning instinct and intelligence. The doings of ants in rendering mutual services, or in caring

for the larvæ or pupæ, have been the subject of curious experiments. Forel, on soiling and deforming the silken cocoons containing the pupæ, always found the next morning that the ants had restored them to their original form and primitive whiteness. Hüber spoke of the precision with which a column of ants moved, and the perfect order the army observed on a long march. Forel, however, shows that this precision would be impossible unless the ants were careful to preserve order. An ant carrying a heavy cocoon, wholly taken up with its burden, is incapable of giving attention to any thing else. Some wander, while others, better assured of their course, go straight on. After much hesitation the wanderers again find the road, as shown by the readiness with which they march on. This is regarded by Forel as an evidence of an excellent memory.

Forel also studied the power of reproduction in the workers. It is known that they sometimes lay eggs. He has shown that by their whole structure such individuals are intermediate between the fecundated females and the workers or neuters. Their ovaries are sometimes completely, sometimes only partially, developed.

He also affords a number of new observations on the architecture of these creatures. He finds that the nests of the same species sometimes vary in their interiors. Forel doubts whether certain ants live in the nests of others, as if parasitic. He finds that two kinds of ants lodged in the same nest occupy separate apartments, with walls separating them. Forel has studied better than any one else the habits of the isolated fecundated females. He has studied and created alliances between the industrious species and those incapable of rearing their young; he has watched their battles, and also noted the influence of temperature and of light on the movements of the ants.

The functions of the anterior pair of ganglia, or so-called brain, of a water-beetle (*Dytiscus marginalis*) have been studied by Faivre. He believes that these ganglia preside especially over the movements of deglutition; that they determine not only the contraction but the dilatation of the pharyngeal sphincter-muscle, which reacts at the same time with the recurrent on the cardiac sphincter. The power peculiar to this nerve-centre can be set in play by impressions

transmitted sometimes from behind forward, or the reverse. He associates through the medium of the brain, to which are attached communicating nerves, the acts of prehension and of mastication to the swallowing of food and the passage of food into the stomach and intestine. The subœsophageal ganglia is the centre, under the influence of which it reacts with the most energy. In brief, the frontal (supraœsophageal) ganglia, distinct by their special rôle from the other nervous centres of the ganglionic chain, approach the former (subœsophageal) by their essential functions as well as structure.

Further contributions to the relations of insects to plants are to be found in Lubbock's "British Wild-flowers in Relation to Insects;" and in Hermann Müller's papers in *Nature*.

The subject of hermaphroditism in the moths (or more properly *gynandromorphism*) has been discussed by Dr. A. S. Packard, Jr., who describes and figures two gynandromorphs of *Callosamia Promethea*. One is a female, with the antenna and wings on the right side masculine, and the other is a male, with the antenna and wings on the right side more like the male than the female. These two cases may be regarded as extreme examples of what may be called *peripheral gynandromorphism;* namely, where the trunk (head, thorax, and hind-body) are not affected, but only the appendages and scales, including the wings, feet, and antennæ; the head and genitals not being affected. The least-marked example of this sort is one described by Westwood, who states that he had an orange-tip butterfly (*Anthocaris cardamines*) which was female in every respect, except that on the tip of one fore-wing were about a dozen of the bright orange scales which characterize the male. It is not known that any Lepidoptera with the internal genital organs affected have been examined, as the examples thus far have not been preserved in alcohol. The best-defined cases of this sort are those described in the honey-bee by Siebold. In these cases the internal and external sexual organs are mixed together much as the other external characters. The sting, with its vesicle and gland, was present, though in a soft state, in the drone, and in the female the ovaries and also spermaries were present, though the ovaries contained no eggs. As to the cause of so-called hermaphroditism, Siebold's explanation

that it is due to an imperfect fecundation of the ovum seems most probable. These cases seem to be paralleled by the occurrence of hybridity between two species, the result being an irregular fusion of the characters of both species. Both seem to indicate that sexual characters, as well as specific characters, are determined at the time of impregnation.

Mr. Scudder's discovery of well-preserved remains of the abdomen of a larval dragon-fly in the coal-measures of Cape Breton sets back a long ways the existence of these insects, the earliest remains heretofore known having occurred in the Lias formation.

As a contribution to fossil entomology, the splendid memoir of Mr. Scudder on fossil butterflies is noteworthy. Nine well-authenticated species of fossil butterflies are now known, all from the European tertiary formation, the earliest known forms occurring in the lower beds. Three of these insects belong to the highest families of butterflies—Nymphales—four to the Papilionidæ, and two only to the Urbicolæ (Hesperians). The allies of four of these fossil butterflies now live in the East Indies; those of three in sub-tropical North America, and one of them in the north temperate zone of both Europe, Asia and America; and those of one in the Mediterranean region. Three out of the four species whose living allies are to be sought in the East Indies come from the older deposits of Aix, and only one of the two remaining Aix species shows special affinities to American types; "We thus find here, as among other insects and among the plants, a growing likeness to American types as we pass upward through the European tertiaries.

"The study of the floras of the European tertiaries has proceeded so far that in most cases we are able to find, in the very beds where the butterflies occur, plants which we may reasonably judge to have formed the food of these insects in their earlier stages. In but a single instance is the family of plants upon which it was necessary, or almost necessary, to suppose the caterpillar fed, entirely absent from tertiary strata; and since this family is the Cruciferæ, which in its very nature could scarcely have left a recognizable trace of its presence, the exception has no force."

Professor Weismann's work on "Seasonal Dimorphism" in butterflies shows that several so-called species are simply

varieties appearing at different parts of summer, either the beginning or close, and that this variation does not occur in the larva state, but is probably due to the different durations of the pupa state. He thinks they are the same in effect with climatic varieties, and that they were induced originally by changes in the climate of Europe during the coming and going of the glacial period. The essay also throws light on the origin of climatic varieties.

The effect of the glacial period on the distribution of insects in North America is discussed by Mr. Grote. The tops of the White Mountains and the Rocky Mountains in Colorado offer us particular kinds of insects, living in an isolated manner at the present day, and confined to their respective localities. In order to find insects like them we have to explore the coast of Labrador, and the northern portions of the North American continent in regions offering analogous conditions of climate to those existing on the summits of these mountains. The genera *Œneis* (Chionobas) and *Brenthis* among the butterflies, and *Anarta* and *Agrotis* among the moths, are represented by the same or similar species in all of the above-mentioned localities. In the case of the White Mountain butterfly, *Œneis semidea*, we have a form sustaining itself in a very limited alpine area on the top of Mount Washington.

The question comes up, with regard to the White Mountain butterfly, as to the manner in which this species of *Œneis* attained its present restricted geographical area. Mr. Grote answers it by the action attendant on the decline of the glacial period. Many of the features of the advance of the glacial sheet were repeated in the reverse order on the subsidence of the main ice-sheet or glacial sea. The local glaciers appeared again, separate from the main bodies of ice, and filled the valleys and mountain ravines, thus running at variance with the main body of the glacier, being determined by local topography. A reversal of the temperature shortened the winters and lengthened the summers. Ice-loving insects, such as the White Mountain butterfly, hung on the outskirts of the main ice-sheet, where they found their fitting conditions of temperature and food. "The main ice-sheet had pushed them insensibly before it; and during the continuance of the glacial period the geographical dis-

tribution of the genus *Œneis* had been changed from a high northern region to one which may well have included portions of the Southern States. And on its decline the ice-sheet drew them back again after itself by easy stages; yet not all of them. Some of these butterflies strayed by the way, detained by the physical nature of the country, and destined to plant colonies apart from their companions."

When the main ice-sheet left the foot of the White Mountains, some of these *Œneis* butterflies were left behind. "At a height of from 5600 to 6200 feet above the level of the sea, and a mean temperature of about 48 degrees during a short summer, the White Mountain butterflies (*Œneis semidea*) yet enjoy a climate like that of Labrador within the limits of New Hampshire. And in the case of moths an analogous state of things exists. The species *Anarta melanopa* is found on Mount Washington, the Rocky Mountains, and Labrador. *Agrotis Islandica* is found in Iceland, Labrador, the White Mountains, and perhaps in Colorado. As on islands in the air, these insects have been left by the retiring ice-flood during the opening of the Quaternary."

Some studies by Mr. W. H. Edwards lead him to differ from Mr. Scudder's conclusions in relation to the two broods, vernal and æstival, of two butterflies, *Argynnis* (Brenthis) *myrina* and *bellona*, which were published in the *American Naturalist* in 1872. Mr. Edwards finds that in *Argynnis myrina* the butterfly of the fall brood emerges from the chrysalis about the 1st of September, lays eggs on or before the 15th, the larvæ hatch between the 20th and the 24th, and go at once into hibernation, to awake in May, and reach the chrysalis state about the middle of June, and the butterfly state about the 25th of June. If any of the summer brood of larvæ hibernate after their third moult (a fact not established), then the larvæ of both broods would awake at the same time and become butterflies at the same time, making the summer brood. It is to be observed that the several stages of the same brood of larvæ do not occur in exactly the same periods of time. From eggs laid on the same day, by the same female, some of the larvæ hatched will reach the chrysalis state several days before others. In the larger species of *Argynnis* there will be such a difference, amounting to two or three weeks. Therefore some of

the larvæ which hibernate at the third moult may be retarded so that their butterflies shall emerge contemporaneously with those which proceed from the larvæ that hibernate as soon as they leave the egg. The case is parallel with that of *Phyciodes nycteis*, and with that of *Apatura celtis*, both double-brooded species, and both disclosing larvæ from the summer brood which hibernate when half grown, while a part of the brood go on to chrysalis and give the fall brood of butterflies, these again producing larvæ which also hibernate. (In both the last hibernation begins after the larva is half grown—*i. e.*, after the third moult in *nycteis*, and after the second in *celtis*.) Mr. Edwards claims that Mr. Scudder has made a hypothetical case which is precisely the actual case that he (Edwards) has above indicated. Scudder's example is as follows, to use his own words: "Should the season be so long that the *second brood could lay eggs*, the caterpillars would then be forced to hibernate as those of the æstival series, and *become members* of that series the next year. Thus the vernal series would continually feed the æstival." Moreover, in no species do the several preparatory stages of its members run even. On the contrary, in any, whether single or double brooded, there will be found by different females eggs freshly laid, eggs ready to hatch, young larvæ and mature larvæ, all at the same time. By this means there is kept up for a long period, often for weeks, a succession of newly emerged butterflies of the same brood, and the newer and older are constantly mating. On one day in September of last year he cut a branch of wild senna (*Cassia*), on which at the moment were newly laid eggs of *Terias nicippe*, larvæ in every stage of growth, and a butterfly of the same species just emerged, and still resting on the empty shell of its chrysalis.

Our knowledge of the transformations of the Lepidoptera has been increased by an illustrated account by Mr. Scudder of the life-history of *Eumæus atala*, a butterfly which feeds on the *Zamia* in Florida. Several Limacodes larvæ are described by Mr. Wetherby, and other larvæ are described in the *Canadian Entomologist*, and by Mr. Henry Edwards in the Proceedings of the California Academy of Sciences.

An interesting contribution to our knowledge of the insect fauna of islands is afforded by the Rev. A. E. Eaton's

researches on Kerguelen Island, while attached as naturalist to the Transit of Venus Expedition. Nearly all the insects were remarkable for being either wingless or with very short wings. Of the flies (Diptera), one species had neither wings nor halteres. Dr. J. L. Le Conte, in his presidential address before the American Association, brings forward some valuable facts in the geographical distribution of insects in North America.

In descriptive entomology there are the usual papers in journals and transactions. The *Canadian Entomologist* contains descriptions of North American insects, while *Psyche*, published by the Cambridge Entomological Club, contains an elaborate bibliographical record, in which a list is given of all writings upon entomology published in North America, and of all foreign writings upon North American entomology, and a brief notice of the contents of each.

Especially worthy of notice are descriptions and synonymical catalogues by Hagen, Scudder, Ostensacken, Grote, Morrison, Chambers, H. Edwards, and others; while in the Proceedings of the Zoological Society are handsomely illustrated papers by Butler. Professor Zeller continues in the Transactions of the Vienna Botanical and Zoological Society his elaborate descriptions of North American moths. In economical entomology the report of Mr. Riley is replete with useful information, particularly regarding the destructive grasshopper and the grape *Phylloxera*.

Coming now to the Vertebrates, we learn that M. Gerbe has studied in the fish-parks at Concarneau the embryology of the rays, embracing all the modifications that the eggs of these fishes undergo from the time they enter the oviduct to that of their exclusion. The swimming-bladder of fishes has been studied by M. Moreau from the side of experimental physiology. He concludes that it is a hydrostatic organ, and not an organ of locomotion.

In a work on the origin of the vertebrates, Dr. Dohrn indulges in some speculations as to the ancestry of these animals. His embryological investigations lead him to seek for the probable ancestors of the vertebrates among the Arthropods (crustacea and insects), rather than the Tunicates or Ascidians; and to revert to the views of the elder St. Hilaire, who described insects as vertebrates which walk with

their backs downward, rather than to those of Kowalevsky and others, who trace the line through the Ascidians and the lancelet. So far from being the representative of the original vertebrates, the *Amphioxus* is regarded by Dr. Dohrn as a degenerate descendant of the cyclostomous fishes, and the so-called larvæ of the Ascidians are the result of a still longer-continued process of degradation.

On account of these and other speculations, renewed attention is being paid to a study of the embryology and anatomy of *Amphioxus*, the lancelet. Mr. Balfour considers that it is not necessary to conclude that *Amphioxus* itself was the ancestor of the vertebrates, but merely that the earliest stages of development of this supposed vertebrate ancestor were similar to those of *Amphioxus*. The egg of *Amphioxus* differs from that of other vertebrate animals in having less food-material or yolk, and Balfour thinks that this accounts for the differences in the early stages of the embryo. Still he thinks that all the modes of development found in the higher vertebrates are to be looked upon as modifications of that of *Amphioxus*. One common feature which appears prominently in reviewing the embryology of vertebrates as a whole is the derivation of the middle germ-layer (mesoblast) from the third or inner layer (hypoblast), though it should be stated that so high an authority as Kölliker thinks that the middle layer is derived from the outer one. Among the invertebrates, however, the middle germ-layer is derived from the inner germ-layer.

Professor Huxley publishes meanwhile a note upon the "brain and skull" of *Amphioxus*. By reason of the supposed absence of renal organs, and of any proper skull and brain, Agassiz was led to separate the lancelet from all other fishes; and Haeckel, going farther, made a distinct division of the Vertebrata (*Acrania*) for its reception; while Semper, in a lately published paper, separates it entirely from the vertebrates. Huxley now describes what he believes to be the representative of the ducts of the Wolffian bodies, or "primordial kidneys" of the higher vertebrates, in *Amphioxus*, and he also endeavors to point out that, although *Amphioxus* has no completely differentiated brain or skull, "yet it possesses very well-marked and relatively large divisions of the cerebro-spinal nervous axis and of the spinal

column, which answer to the encephalon (brain) and the cranium of the higher Vertebrata." Professor Ray Lankester also contributes an important paper on the anatomy and embryology of *Amphioxus* as compared with the higher fishes.

Some important notes on the grayling of North America, by James W. Milner, and on the natural history of the *gourami*, by Dr. T. Gill, are contained in the report of the United States Commissioner of Fish and Fisheries.

Some new fossil fishes from the Devonian and carboniferous rocks of Ohio have been described by Professor J. S. Newberry. Of these the most important discovery was nearly the entire skeleton of *Dinichthys Terrellii*, the largest of all the old armor-plated Ganoids. In another species (*D. Hertzeri*), the maxillaries and mandibles are set with teeth instead of being sharp-edged. Professor B. G. Wilder also presented a paper to the American Association for the Advancement of Science, entitled "Notes on the American Ganoids" (*Amia*, *Lepidosteus*, *Acipenser*, and *Polyodon*).

A revised list of the fishes of Greenland, by Dr. Lütken, is given in the appendix to the English "Arctic Manual."

The habits of the pine snake, by Rev. S. Lockwood, are described in the *American Naturalist*. A new species of serpent, belonging to an undescribed genus, collected by Lieutenant Wheeler's expedition in Arizona, has been described by Professor Cope under the name of *Monopoma rufipunctatum*. The rostral shield of this new genus resembles that of *Phimothyra*, and the lateral head-shields those of *Cyclophis æstivus*. It is, however, more like *Eutænia*, the common garter-snake, in general character.

It is asserted by M. Gaudry that true-tailed Batrachians, with affinities to the modern Salamanders, existed in Permian rocks in France. Interesting discoveries of fossil *Batrachia* in the coal-measures of Ohio have been brought out by the geological survey of that state under the direction of Professor Newberry. The number of extinct forms have been thus increased to thirty-three. Professor Cope, who has studied the material, describes a new genus and species under the name of *Pleuropteryx clavatus*. It is remarkable for the structure of its ribs. Each of these presents a wide, thin ala on its posterior face, which is abruptly discontinued below. The shaft of the rib is short, and enlarged dis-

tally where it is hollow and truncate. The vertebræ are as large as those of the anaconda. Another genus exhibits two strata of chevrons in an armature of ventral rods, the angle of the upper having an opposite direction to that of the lower. The gular scutæ are smooth. It was named *Hyphasma lævis*. An interesting addition to the fauna was stated to be a new species of the horned genus *Ceraterpeton* of Huxley. The head is relatively large, and covered with reticulate ridges separated by rows of impressed dots. The horns are long, stout, and incurved. It is called *C. puncto-lineatum*.

In the course of some remarks on the Batrachians and Reptiles of Florida, Professor Cope stated that this state formed a distinct subdivision of the Austro-Riparian region (see Gray's Atlas of the United States, 1873, for a review of the geographical distribution), the evidence furnished by the lower vertebrates confirming that derived from the higher vertebrata and the plants. There are fifteen species of Batrachia and Reptilia not found in any other part of North America; three of these occur in Cuba, but none elsewhere. He states that Mr. Meek had recently sent to the museum of the Smithsonian Institution an *Elaps distans*—a poisonous snake—which had been known previously from the Sonoran region only. This discovery may be associated with that of the Western burrowing owl in Florida, and the fact that the Floridan *Ophibolus getulus* presents the same number of rows of scales as the black and white *Ophiboli* of the Sonoran region.

The first fossils found (by Professor Cope while attached to Wheeler's survey) in the "trias" of the Rocky Mountains are those of fishes and reptiles. The fishes are represented by scales of small species, which are abundant in the coprolites of the reptiles; the latter represent the three orders of *Crocodiles*, *Dinosauria*, and apparently of *Sauropterygia*. The dinosaurian order is represented by a part of the crown of a tooth of a species of large size, of the general character of *Lælaps*. Both faces are convex, the one more so than the other, and the long axis of the crown is curved toward the less convex side. Both cutting-edges are sharply and closely crenate denticulate, as in *Lælaps*, *Aublysodon*, etc.; otherwise the enamel is perfectly smooth.

The structure of the central nervous system of the turtles and of the axolotl has been elucidated by Dr. Stieda in Siebold and Kölliker's *Zeitschrift.*

The *Crocodilia* are divided by Professor Huxley into three sub-orders, as follows: 1. *Parasuchia*, containing the genera *Stagonolepis* and *Belodon;* 2. *Mesosuchia*, with the genera *Steneosaurus*, *Pelagosaurus*, *Teleosaurus*, *Teleidosaurus*, *Metriorhynchus* (*Goniopholis? Pholidosaurus?*); 3. *Eusuchia* (*Thoracosaurus*, *Holops*, and recent forms).

In last year's *Record* we announced the discovery of the crocodile by the late Professor Wyman in Florida. During the past year M. Hornaday has published an article on this animal in the *American Naturalist*, with figures of the head and skull. A large male measured fourteen feet in length; its mate, a female, ten feet eight inches. It is regarded by the author as a new species, for which he proposes the name *Crocodilus Floridanus.*

Another link in the chain of evidence showing the affinities of the birds with the reptiles—a subject engrossing the attention of comparative anatomists—is afforded by fresh studies by Professor Morse on the "intermedium" bone of birds. Last year he found this bone in the tern. During the present year he ascertained the presence of this bone in the petrel, sea-pigeon, and eider-duck. This additional evidence showed beyond question the existence of four tarsal bones in birds, as well as four carpal ones. In making these investigations he had also discovered embryo claws on two of the fingers of the wing—the index and middle finger. Heretofore in the adult bird a single claw only had occurred in a few species, such as the Syrian blackbird, spur-winged goose, knob-winged dove, jacana, mound bird, and a few others; and in these cases it occurred either on the index or middle finger, or on the radial side of the metacarpus. All these facts, he claims, lend additional proof of the reptilian affinities of birds.

By far the most important discovery proving the reptilian affinities of birds was the discovery in 1872, by Professor Marsh, of birds with veritable teeth in sockets in the jaws, much as in reptiles. Professor Marsh now fully describes and figures these bird-skulls and teeth, and proposes the term *Odontornithes* for the new sub-class, with two orders: *Ich-*

thyornithes (with the genera *Ichthyornis* and *Apatornis*) and *Odontolcæ*, containing the genus *Hesperornis*. In comparing the two genera, *Ichthyornis* and *Hesperornis*, the author calls attention to the remarkable combinations of characters in each genus. The former has teeth in distinct sockets, with biconcave vertebræ; while the latter has teeth in grooves, and yet has vertebræ similar to those of modern birds. They all occurred in the upper cretaceous beds of New Jersey and Kansas. The remains preserved of *Hesperornis regalis* show that this species was larger than any known aquatic bird, the length from the apex of the bill to the end of the toes being between five and six feet. The rudimentary wings prove that flight was impossible, while the powerful swimming legs and feet were peculiarly adapted to rapid motion through the water. The tail appears to have been much expanded horizontally, as in the beaver, and doubtless was an efficient aid in diving, perhaps compensating in part for want of wings, which the penguins use with so much effect in swimming under water. That *Hesperornis* was carnivorous is clearly proved by its teeth, and its food was probably fishes.

The coloring matter of the shell of the eggs of birds has been studied by Mr. Sorby with the solar spectroscope. He finds that their different tints are due to a variable mixture of seven well-marked coloring matters. Hitherto the greater part of these had not been found elsewhere. The principal red coloring matter was connected with the hæmoglobin of blood, and the two blue coloring matters were probably related to bile pigments; but in both cases it was only a chemical and physical relationship, and the individual substances were quite distinct, and it seemed as though they were special secretions. There appears to be no simple connection between the production of these various egg-pigments and the general organization of the birds, unless it were in the case of the *Tinamous*, in the shells of the eggs of many species of which occurs an orange-red substance not met with in any other eggs, unless it were in those of some species of cassowary.

A fossil bird belonging to the Vultures has been discovered by Professor Cope, and named *Vultur umbrosus*. It was about as large as the "king vulture" (*Cathartes papa*)

of Mexico. The true vultures do not exist at present in the Western hemisphere, and the present determination adds one more Old World type to the extinct fauna of the United States. The genus *Vultur* is now associated in Africa and India with *Rhinoceros*, camels, horses, etc., as in the period of the late tertiary in New Mexico.

A new work on the locomotive apparatus of birds, by M. Alix, contains a careful study of the skeleton and muscular system.

The subject of instinct in birds and mammals has again been discussed by Mr. Spalding in *Nature*. He claims that the instincts of animals appear and disappear in such seasonable correspondence with their own wants and the wants of their offspring as to be a standing subject of wonder. They have by no means the fixed and unalterable character by which some would distinguish them from the higher faculties of the human race. It is a common practice to hatch duck's eggs under a hen, though in such cases the hen has to sit a week longer than on her own eggs. Mr. Spalding tried an experiment to ascertain how far the time of setting could be interfered with in the opposite direction. Two hens became broody on the same day, and he set them on dummies. On the third day he put two chicks a day old to one of the hens. She pecked at them once or twice, seemed rather fidgety, then took to them, called them to her, and entered on all the cares of a mother. The other hen was similarly tried, but with a very different result. She pecked at the chickens viciously, and both that day and the next stubbornly refused to have any thing to do with them. Birds, he maintains, do not *learn* to fly. On shutting up five unfledged swallows, they flew when liberated as well as the old ones. Such he found to be the case with titmice, tomtits, and wrens. With man, as in the lower animals, Spalding believes that the progress of the infant is but the unfolding of inherited powers. "With wings there comes to the bird the power to use them; and why should we believe that because the human infant is born without teeth, it should, when they do make their appearance, have to discover their use by a series of happy accidents?" In common with other evolutionists, Spalding believes that "instinct in the present generation may be regarded as the

product of the accumulated experiences of past generations."

A specimen of an almost complete Solitaire (*Pezophaps solitarius*) was found, with a second, in the island of Rodriguez by Mr. J. Caldwells. These specimens, together with that procured by Mr. Slater, one of the naturalists of the Venus Transit Expedition, will settle some points in the osteology of the peculiar extinct Columbine birds, of which so many separate bones have been obtained.

New light has been thrown on the mode of occurrence in New Zealand of the bones of the moa (*Dinornis*) by Dr. Hector. He demonstrates most conclusively, according to *Nature*, that the Maoris told the Europeans of their existence. He believed that there was no hope of ever finding the birds alive, for he had been over the whole of the islands very thoroughly without seeing them. He thought that these gigantic birds lived in the open and low scrub, in which they could walk, not among the forests. In all this region, within his own memory, the moa bones were extremely abundant in the South Island, all over the ground. In the enormous extent of subalpine country in the South Island, which was covered by only a light vegetation, large quantities of well-preserved moa remains have been recently found, associated with the remains of the natives. It appeared to him that the natives had pressed up the country for the purpose of capturing, killing, and eating the moas; and as the natives could not follow them through the sharp bayonet-grass and other underscrub, they drove them together and destroyed them by fire. Moa remains also occur in caves, turbary deposits, and dried-up swamps; the bones got out of a swamp remains indicating at least 1700 individuals. He did not think that moa bones occur in the tertiary deposits, but a true bird-bone, which had been found in such deposits in New Zealand, he was inclined to think belonged to a gigantic extinct penguin. A new contribution to the anatomy of the gigantic birds of New Zealand, by Professor Owen, in the Transactions of the Zoological Society, contains a restoration of the skeleton of *Cnemiornis calcitrans*. It was a goose-like bird as large as a cassowary. Those gigantic birds, the cassowaries, are found to be more numerous in species than formerly supposed. A short time ago but one cassowary was recognized by natural-

ists. Recent expeditions into the less-known portions of New Guinea and adjoining islands have furnished nine forms in all, of which six are said by Mr. Sclater to be now living in the Gardens of the Zoological Society of London. Mr. Sclater gives in *Nature* a brief synoptical table of the genus. The memoir in full, with colored illustrations, appears in the Transactions of the Zoological Society of London.

Some notes on birds which have been found in Greenland are communicated to the *Ibis* by Professor Newton. They will prove of much interest to American ornithologists. A new wren has been found in Florida by Mr. C. J. Maynard, which is described by Mr. Ridgway in the *American Naturalist* under the name of *Thryothorus Ludovicianus*. In coloration this strongly marked form closely resembles *T. Berlandieri* of the lower Rio Grande, but its size is much greater than even the most northern examples of *Ludovicianus* proper, while *Berlandieri* is smaller. Says Mr. Ridgway, "It is very remarkable that the southern form of this bird should be so much larger than the northern one, in direct opposition to a recognized law of climatic variation; but we have another case of this same exception to the rule in *Catherpes Mexicanus*, and its northern race, *var. conspersus*." These examples probably justify the suggestion made by Ridgway that an exception to the rule of decrease in size to the southward, in resident species, may be made in case of families or groups of families, which have in temperate latitudes only outlying genera or species, the increase in this case being to the southward, or toward the region in which the family or group is most highly developed.

Comparative and detailed descriptions of *Nisus Cooperi* and *N. Gundlachi* are offered by Mr. Ridgway, who also publishes in the Proceedings of the Academy of Natural Sciences of Philadelphia a monographic account of the Buteonine subgenus *Craxirex*.

A list of the birds of the Philippine Islands, numbering ninety-six species, and greatly extending our knowledge of the birds of the East Indies, is contributed by Viscount Walden to the Transactions of the Zoological Society of London. It is illustrated by eleven plates.

Some unpublished drawings of the Dodo and other extinct birds of Mauritius were exhibited by Professor Newton at a

meeting of the Zoological Society of London. They are contained in the original manuscript of a journal kept during the voyage of a Dutchman to Mauritius in 1601–1602. Among the birds also represented were *Aphanapteryx brœcki* and *Psittacus mauritianus*. The figures of the Dodo, rough as they are, "must have been drawn by no ordinary hand, and evidently from the life. The various attitudes in which the bird is represented certainly assist us in forming a conception of what it must have been like."

Notes on *Falco labradorus* and other species, by H. G. Dresser; on Peruvian birds by Mr. Sclater, and other papers, anatomical and descriptive, by Rowley, Ganod, Mivart, Sharpe, Whiteley, Layard, Salvin, Sclater, and others, occur in the Proceedings of the Zoological Society.

Contributions to the anatomy of the mammals are contained in an elaborate memoir on the Daman by M. George, published with a number of plates in the *Annales des Sciences Naturelles*. Professor W. S. Barnard has compared the muscles of man with those of the higher apes, showing the points of similarity as well as of difference. A point made in this paper was the statement that one of the buttock muscles supposed to be peculiar to the higher apes, distinguishing them from man, really existed in the human body, and in a similar position. It was shown that the muscle thus described by Traill, and afterward by Wilder, as existing in the chimpanzee, and by Owen and Bischoff in the orang, and by Coues in the opossum, is also found in man, and offers no distinction in this respect. His investigations tend to prove that all the muscles possessed by man can be traced backward in the lower form of animals, through the apes to the lemuroids.

The indications of descent exhibited by North American Tertiary mammals have been shown by Professor Cope in the gradual development from one form to another by changes in the foot bones through a long series, beginning with the extinct Tertiary mammals, and ending with those of the present day. A similar process of change was traced in the teeth of animals, the simpler forms of teeth in the Eocene formation being a crown with four tubercles. The human skeleton, he declares, retains many more ancient types than other mammalia.

The extensive and very fully illustrated work by Professor Cope, entitled "The Vertebrata of the Cretaceous Formations of the West," published in the Reports of Hayden's United States Geological Survey of the Territories, is replete with new data regarding the wonderful fauna which inhabited the ancient lakes of the far West. After giving in an introduction his views on the significance of paleontological science, he divides the work into three parts. The first part is devoted to the classification and distribution of the Cretaceous deposits of the West; the second part contains descriptions of the Cretaceous Vertebrata of the West; while the third part is occupied with a synopsis of the known Cretaceous Vertebrata of North America. The work is illustrated with fifty-seven lithographic plates.

It has been stated, says Cope in this work, that the life of the present period in the Southern hemisphere is not homogeneous. The same is true, though in a less degree, of the Northern. Thus, if we include India in the latter, the elephant is a Pliocene form, and the true rhinoceros Upper Miocene. In the Northern hemisphere the dogs are Miocene. In North America, the opossum, and probably the raccoon, are Eocene; the wolves and foxes appeared in the Miocene age, and the weasels in the Pliocene. Perhaps the cats first appeared in the American Pliocene. Comparatively few mammalian types mark, by their origin, the latest geologic epochs. Such are the ruminants, as deer and oxen, with the true horses, which all commence in the Upper Pliocene of the Northern hemisphere. Finally, man alone signalizes the last or glacial period, and is to reach his culmination in the ages that intervene between that great time-boundary and one to come. Thus a certain proportion only of the life of a given epoch is characteristic of it—that is, originates in it; the remaining members being legacies from preceding ages. Hence the latest forms of life embraced in an extinct fauna are the true indicators of the chronological relations of that fauna. The total number of North American Cretaceous Vertebrates enumerated and described is 253, of which 97 are fishes, 147 reptiles, and 9 are birds. No mammals have yet been discovered.

Whether thoroughbred stock of old and well-established herds ever reverts to the original type is called in question

by Professor Brewer, as he asserts that there is no proof of this "dogma." He thinks that the practical breeders of thoroughbred stock (of whatever kind) commonly believe that so long as the breed is kept pure and no other blood mingled, that, although the animals may vary greatly in excellence, all of them will have the essential characters which distinguish that breed from all other breeds or "types." On the other hand, many persons (not breeders of thoroughbred stock so far as he knows) have asserted that, if neglected, any breed will "revert to the original type." That *grade* animals often "revert," that curious freaks and sports often attend violent crossing (and also that breeds *deteriorate* under bad management or bad conditions), are well enough known; but these facts do not affect the specific questions asked (in a printed circular), where *the blood is supposed to have been kept strictly pure.*

The address of Mr. Sclater before the section of Biology of the British Association for the Advancement of Science was on "The Present State of our Knowledge of Geographical Zoology." It was restricted to the Vertebrates, but is a useful discourse.

"Bats and their Young" is the title of an article by Professor B. G. Wilder in the *Popular Science Monthly*, and contains much new material regarding the early stages of these animals. He has also contributed to the *American Journal of Science* a description of a fœtal manatee.

Important monographic accounts of the *Saccomyidæ*—the group of Pouched Mice—and the *Geomyidæ*, or Gophers, have been published by Dr. Coues; while Mr. J. A. Allen has published in the Proceedings of the Boston Society of Natural History a synopsis of American *Leporidæ*, or Hares, the present paper being an abstract of a monograph now in preparation. Several papers on new or little-known mammals by different writers are contained in the Proceedings of the Zoological Society of London and other serials.

A new fossil *Lemur* has been described in the Proceedings of the Academy of Sciences of Philadelphia by Professor Cope, from the Eocene and Tertiary deposits of the Rocky Mountains. It belongs to a type which he had originally shown to have relations with the *Procyonidæ* and other related low forms of Carnivora. Professor Cope has also dis-

covered in one of the Pliocene formations of the West a new species of dog of large size, which he calls *Canis ursinus*.

Professor Cope has discussed the phylogeny of the camels, based on several genera of fossil camels exclusively North American, as no well-determined form of this group has been found fossil in the Old World. Until such are discovered, there will be much ground for supposing that the camels of the Old World were derived from American ancestors; while the presence of the llamas in the existing South American fauna indicates the absence there of the conditions which caused their extermination from North America. A new species of *Mastodon* has also been described by Professor Cope, from New Mexico, discovered while he was attached to Wheeler's survey.

A gorilla, exported to Hamburg, where it soon died, has been preserved in spirits, and is to form the subject of a monograph by Dr. Bolau, by whom several important and doubtful points in the anatomy of the anthropoid apes may be settled.

The embryological history of man, as compared with other vertebrates, has been treated of in a popular work by Haeckel, entitled "Anthropogeny, or the Developmental History of Mankind." The work is being translated into English.

BOTANY.

Insectivorous Plants.—Three ways are now recognized by which plants entrap insects. First, as in *Dionæa muscipula*, or Venus's fly-trap, where the two blades of the leaf close rapidly together, and the cilia upon the edges interlock so as to imprison any insect which may happen to be inside; second, as in different species of Drosera, where the leaves are covered with hairs, at whose tips is a sticky exudation by which insects are caught; third, as in different species of Utricularia, where the leaves are furnished with small bladders, into which small insects crawl, but are prevented from leaving by a peculiar arrangement of hairs around the orifice. In Dionæa there are three highly sensitive hairs in the centre of the two lateral portions of the upper-part leaf, and the closing of the leaf takes place when insects or foreign bodies come in contact with these hairs. In addition to the highly sensitive hairs just mentioned, there are also glands on the

upper surface of the leaf which secrete an acid juice by which the captured insects are digested. In Drosera, when any body has been caught by the sticky fluid at the end of a hair, an impulse is conveyed through the hair to those on other parts of the leaf, which causes them to bend over until they touch the object caught. They then secrete an acid juice by which it is digested. In Utricularia, the insects caught in the leaf-bladders slowly decompose. Darwin has made very careful investigations on the process of digestion in Drosera and Dionæa, and comes to the conclusion that the secreted fluid in both cases is closely allied to, if not identical with, the gastric juice. Although contact of almost any foreign body will cause, in one case, the hairs to bend over toward it, in the other the leaf itself to close suddenly, the digestive power of the secreted fluids in both cases is only capable of digesting nitrogenous substances. Salts of ammonia seem to have the greatest effect on the hairs of Drosera, and especially phosphate of ammonia, extremely minute quantities of which have a powerful effect. The leaves of both Drosera and Dionæa seem to be insensible to falling drops of rain and currents of air.

Distribution of Seeds.—At the request of M. Alphonse de Candolle, a number of experiments were made by M. G. Thuret, of Antibes, France, to ascertain how long different seeds and fruits would float on salt water. He concludes, contrary to the opinion of Martins, that distribution of plants by means of ocean currents can take place only to a very limited extent, as in by far the greater number of his experiments seeds and fruits sank either at once or in a few days. M. Thuret also experimented on the power of germination of seeds after continued immersion in salt water. Out of the seeds of thirty-three species, which were immersed for thirteen months, twenty-four were in good condition and were sown in pots. Of these twenty-four, ten grew.

Disease of Orange-trees.—The orange-trees of California have lately been attacked by the fungus *Capnodium Citri*, Berk. and Desm. The disease is recognized by the leaves being covered with a blackish powdery substance, which can without difficulty be wiped off. At the same time a disease attacked the olive-trees. The name given to the fungus in the latter case is *Antennaria elaiophila*. This is

probably only a sterile form of the fungus found on the orange-trees. A similar disease also attacks the guava. The disease of the olives has been known for a long time in the south of France, but no remedy has been proposed. The disease of the orange is known to occur in several tropical countries.

Male and Female Organs in Agarics.—Almost simultaneously, the discovery of antheridia and carpogonia in species of Coprinus, a kind of toadstool growing on dung, has been announced by Professor Max Rees in his inaugural address at Erlangen, and by Professor P. Van Tieghem in the *Comptes Rendus;* and farther details have been given by E. Eidam in the *Botanische Zeitung.* Some of the spores of Coprinus germinate and produce tufts of antheridia, while others bear round cells with a slight projecting point, which are the carpogonia. The contact of the antherozoids with the carpogonia causes a change in the latter, which grow up into the visible stem and pileus of the Coprinus. This recalls the process of fertilization in the Ascomycetes.

Red Snow Plant.—The red snow plant (*Hæmatococcus*, or *Protococcus nivalis*) has been shown in a paper by Dr. Joseph Rostafinsky, published in the Memoirs of the Academy of Sciences of Cherbourg, to be identical with the common *Hœmatococcus pluvialis*, and the name applied by him to both is *Hæmatococcus lacustris.* The plant is propagated by zoospores, of which there are two kinds; but, in spite of the opinion of Velter, there is no copulation of zoospores in this case. The amount of cold which the zoospores of this plant will endure without apparent injury is something extraordinary. They have been known to be frozen solid, and yet recover on melting of the ice about them.

Effects of the same Temperature upon Plants of Different Latitudes.—It having been asserted that vegetation is more promptly acted upon by the rise of temperature in spring in higher than in lower latitudes, M. Alphonse de Candolle reported in the *Comptes Rendus* some experiments on the subject. Seeds of three or four different annuals were sent from Northern and Southern Europe to Geneva. In one of the species the northern seed developed first. Again, branches of poplar, tulip-tree, and catalpa were sent from Montpellier to Geneva, and paired with similar branches taken from

trees at Geneva. Both sets of branches were then placed in a cold room until they were penetrated by the same temperature, and then placed in glasses of water and removed to a warm room. The result was that the branches from trees growing at Geneva leafed out earlier by from eighteen to twenty-three days than those brought from Montpellier. M. De Candolle assigns two reasons for this precocity. First, he thinks that there has been a natural selection of the buds. The buds of a tree are in a continual struggle. The later, like the badly placed ones, develop imperfect branches, which are often stifled. The most precocious prevail, unless indeed they suffer from frost. In this way comes a selection, and a successive adaptation of the tree to the climate. How far this selection applies is a little doubtful, for the precocity is as likely to be disadvantageous as advantageous in a northern climate. The cause of the difference in the vegetation of northern and southern individuals is probably the more complete hibernal repose of the former, rendering them more susceptible to the heat of spring.

Potato Rot.—The oospores of the fungus which causes the potato rot (*Peronospora infestans*) have been discovered by Mr. Worthington Smith, of England. They are found in the substance of the potato leaves, where they form black spots. They occur more frequently in the leaves of American varieties of potatoes than in others. The fungus was at first supposed to be a Protomyces; but Mr. Smith, by macerating the leaves, found bodies similar to those described by De Bary as the oospores of species of Peronosporæ. As a practical result of this discovery, farmers need have no fear of planting potatoes after grain or clover, against which they had been warned, as the rot is not propagated by these crops. Also the stems and leaves of infected plants should be removed as soon as possible. The potato rot made its appearance in California, for the first time it is believed, in the month of May last, at least two months earlier than its usual appearance in the Middle and New England States.

Plum-Pockets.—The curious disease known in Germany as Pflaumen Narren, or Taschen, was observed near Boston in the month of June. The disease is caused by a fungus, *Ascomyces Pruni*, which distorts the young plums, making them appear at first swollen and then wrinkled. On cutting

the fruit open it is found to be hollow. The disease is not uncommon in Germany, and has been reported in New Brunswick. The fungus is closely related to *Ascomyces deformans*, which attacks peach leaves, making them curl up.

Diseases of Forest Trees.—In the *Wichtige Krankheiten der Waldbäume* Hartig gives an interesting account of some of the diseases of European forest trees. He mentions, among other fungi injurious to coniferous trees, *Agaricus melleus*, and considers that the sclerotium form known as *Rhizomorpha subcorticalis* is nothing but a state of the mycelium of this species. It is curious to note how very large a proportion of fungi, recognized as injurious to forest trees, attack species of Coniferæ. According to the views of Hartig, not only are the different members of the order Uredineæ, as *Æcidium Pini*, Pers., *Cæoma pinitorquum*, A. Br., *Cæoma Laricis*, R. H'rtg., found injurious to coniferous trees, but also members of the orders Hymenomycetes and Ascomycetes. Of the former order, *Agaricus melleus*, L. *Trametes Pini*, Fr., and *Trametes raciperda*, R. H'rtg., are particularly mentioned as injurious to Coniferæ; but the former species, at least, also attacks other kinds of trees as well. Of the Ascomycetes attacking Coniferæ, *Peziza Willkommii*, R. H'rtg., is peculiar to the larch.

Club-foot in Turnips.—Farmers have long been familiar with a diseased form of turnip-roots in which they swell up and become very crooked and ill-shaped. This was supposed to be caused by the attacks of some insect, and, in fact, such roots when harvested are almost always found to be covered with insects. M. Woronin, of St. Petersburg, near which city the disease has just made its appearance, has investigated the subject, and comes to the conclusion that the trouble is caused by some vegetable organism, hitherto unknown, resembling in some respects the Myxomycetes, in others the Chytridineæ.

Growth of the Vegetable Cell.—Dr. Moritz Traube, at the meeting of German physicians and naturalists at Breslau, gave some account of experiments with artificial cells. When two colloid substances, which give precipitates with one another, are brought together in solution in such a way that a drop of one is introduced into a mass of the other, a pellicle is formed around the drop. Traube made use of a solu-

tion of tannic acid, into which he let fall a drop of a solution of glue. An artificial cell-wall was then formed around the drop, which gradually enlarged. Taking this as equivalent to a parenchymatous cell of a plant, Traube concludes that the wall of the cell arises by chemical precipitation, and that growth of the cell-wall is by intussusception. In the *Botanische Zeitung* for June 25, Reinke gives an account of some experiments which he thinks confirm Traube's view of the growth of the cell-membrane by intussusception.

The Schwendener Theory of Lichens.—The theory of the algo-fungological nature of lichens, first proposed by Schwendener, has many advocates and as many opponents. Among the advocates is M. Bornet, whose account of the gonidia of lichens appeared a year and a half ago in the *Annales des Sciences;* he has since published a second note on the subject, in which he mentions that he has seen cases of Opegrapha varia, Pers., in which the gonidia have produced the sporangia proper to Trentepohlia (Chroolepus Auct.). On the other hand, Dr. G.W. Körber gives the following reasons for his belief that the gonidia of lichens are not algæ: First, in true algæ the gonidia never produce hyphæ, while this is of common occurrence in the spores of lichens; second, that if the contrary were true, it is strange that in every lichen several types of algæ are necessary for the production of the lichen, and still more strange that in nature these various algæ occur without any further result; third, because many forms of gonidia are not known to algologists as such, because they have never been seen in a free state; fourth, because the lichen gonidia correspond in their forms only to those algæ which reproduce themselves by division, and not to those which propagate by sexual reproduction, the former process being only a physiological one common to many or all lower vegetable cells, and destitute of systematic value. The question is by no means settled as yet, for, although the advocates of the theory do not include many leading lichenologists (including under that term those who devote themselves exclusively to the determination and description of species of lichens), it does include the majority of the best vegetable histologists in Europe. It is often said that, were the theory true, the professional lichenologists would be the first to recognize it, as they have had a much larger experience than others. The contrary,

however, seems to be the fact. The lichenologists, as the term is generally applied, look at the question from one side only. Their object is to describe and arrange large numbers of species, not to follow out the details of the development of any one. In classifying their species, the professional lichenologists have made use principally of the fruit, and paid but little attention to the gonidia. It is the presence of gonidia which, even according to the lichenologists, is characteristic of the lichen rather than the fruit, which is, as is admitted by every one, precisely similar to that of the ascomycetous fungi. The structure of the gonidia and their development has been vastly better made out by Schwendener and Bornet than by any of the lichenologists proper, who, instead of giving good figures and accurate descriptions of the growth of the gonidia from the hyphæ, which they maintain takes place, are satisfied with the mere statement that some one or other, not noted for his skill at the microscope, has seen, or thinks he has seen, this growth. If such an organic union between the hyphæ and gonidia exists, certainly skillful microscopists, whether lichenologists or not, ought to be able to see it. But such is not the case. If the Schwendener theory is not tenable, the only feasible theory is that of Professor Theodore Fries, who believes lichens are bodies consisting of hyphæ, or threads, and gonidia, and that the latter can exist without the former, and when found free have been erroneously considered algæ by some botanists; that is to say, the Oscillarieæ, the Palmelleæ, and other groups of algæ, are not really algæ at all, but gonidia of some lichen which have escaped and are living free. This view might be considered the true one were the gonidia of lichens limited to such forms as Oscillaria, Rivularia, and Palmella, whose method of reproduction differs somewhat from that of plants which are universally recognized as algæ. But in the genus Opegrapha the gonidia correspond in appearance to a genus of algæ known as Chroolepus, and M. Bornet has shown that they are propagated in the same way. Now Chroolepus is nearly related to Cladophora, and many other genera of undoubted algæ; and if we suppose that Chroolepus is nothing but an escaped form of lichen-gonidia, we must make the same supposition with regard to Cladophora, Chætomorpha, and other genera which live in both salt and fresh water,

and have never been found united with any hyphæ. Such a supposition is, of course, entirely out of the question.

Copulation of Zoospores.—Professor J. E. Areschoug, of Upsala, has observed the conjugation of zoospores in *Dictyosiphon hippuroides*, Lyngb. This is the first member of the large group of Phæosporæ, which includes such large plants as the devil's apron of the east coast and the great kelp of California, as well as a multitude of minute filamentous species in which any sexual process has been discovered. Professors Areschoug, Pringsheim, and others, have already reported several cases of conjugation of zoospores in the Zoosporæ, which resemble the Phæosporæ as far as their zoöspores are concerned.

Marine Algæ of the United States.—Dr. E. Palmer has made some interesting additions to the United States marine flora during his stay at Key West. He found growing abundantly *Sargassum dentifolium*, previously known only in the Red Sea, and therefore not to be looked for in the United States; also a single specimen of a Polyphysa, an Australian genus. At Nassau he found *Cystoseira myrica*, also of the Red Sea, the first member of the genus reported on the east coast of North America. Dr. Palmer has also made collections of rare and interesting plants on the island of Guadalupe, off the west coast. *Sargassum piluliferum*, of the coast of Japan, was found by him there. Nearly all the species recently added to the California marine flora have been species occurring in Chili and the southwestern coast of South America, with a few species common to the Cape of Good Hope and to Spain and Portugal. The latest collections seem to indicate a great uniformity of species of the west coast of America from Vancouver's Island to Patagonia, branching off into distinct arctic and antarctic floras.

New Classification of Thallogens.—In the fourth edition of Sachs's "Lehrbuch der Botanik" a new classification of Thallogens is given, which, with some modifications, is likely to be generally adopted at no very distant date. The division of Thallogens into lichens, fungi, and algæ has been the basis of all works on cryptogamic botany for many years. The distinctions between these three groups are as follows: Algæ contain chlorophyl, grow in water or very wet places, and are epiphytic, never parasitic; fungi are without chlorophyl, grow

in the air, very rarely submerged, and are parasitic; lichens are composite plants, having fruit similar to fungi and thalli, which are composed of hyphæ, or threads, in which are various-shaped alga-like bodies called gonidia. Sachs does away with these three divisions, and divides all the Thallogens into two parallel groups—one in which the members contain chlorophyl, the other in which they are destitute of it. There has long been observed a parallelism between certain groups of fungi and algæ, as between the Conjugatæ of the algæ and the Mucorini of the fungi. Sachs brings such parallel groups together, and divides each group into two portions, in one of which the plants contain chlorophyl, in the other of which they do not. Sachs's scheme is as follows:

THALLOGENS.

First Class.

PROTOPHYTES.

Containing Chlorophyl.	*Without Chlorophyl.*
Cyanophyceæ.	Schizomycetes.
Palmelleæ (in part).	Saccharomyces.

Second Class.

ZYGOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Conjugation of Moving Cells.	
Volvocineæ.	Myxomycetes.
(Hydrodictyeæ.)	
Conjugation of Stationary Cells.	
Conjugateæ (incl. Diatomes).	Zygomycetes.

Third Class.

OOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Sphæroplea.	Saprolegniaceæ.
Vaucheria.	Peronosporeæ.
Œdogonieæ.	
Fucaceæ.	

Fourth Class.

CARPOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Coleochæteæ.	Ascomycetes.
Florideæ.	Æcidiomycetes.
Characeæ.	Basidiomycetes.

Sachs regards the presence or absence of chlorophyl as a physiological, not a structural character, and consequently

not to be taken into consideration in dividing the Thallogens into classes. The Protophytes, as defined by Sachs, constitute a group of which we know but very little, and future studies may prove that it is not sufficiently well characterized. In the present state of our knowledge, however, Sachs's group of Protophytes is as good as any. The class of Oosporæ is a very natural one; but the same can not be said of the Carposporæ, which, although in the main well characterized, include plants whose position in that order is, to say the least, doubtful.

Attar of Roses.—The Attar of Roses of commerce comes almost entirely from Roumelia, on the southern side of the Balkan Mountains. It is obtained from the flowers of *Rosa damascæna*, and, according to Mr. Baker, of Kew Gardens, ranges from France to Asia Minor.

Flora of Guadalupe.—The island of Guadalupe, off the coast of California, has recently been visited by Dr. Edward Palmer, and a report on the Phænogamous plants and higher cryptogams collected by him was made by Mr. Sereno Watson, of Cambridge, to the American Academy of Arts and Sciences, November 10th. The island is in latitude 29° north, about 220 miles from San Diego. It is only 25 miles long by 10 broad, and its highest point is 3900 feet above the level of the sea, yet the vegetation of the southern and eastern portions of the island attains its perfection full two months before that of the rest of the island. It has probably never been inhabited until within a few years, yet goats have already begun to produce a disastrous effect upon the native flora of the island. The number of species of higher plants collected by Dr. Palmer was 133, distributed as follows: 102 exogens, 8 endogens, 21 vascular cryptogams, and 2 undetermined plants. With regard to the flora, Mr. Watson says: "Looking at the relative proportion which the large orders bear to each other in this limited flora as compared with the flora of Great Britain, which is the only similar one of which we have the data for comparison, we find that the proportions which the Compositæ and Leguminosæ bear to the whole are identical in both, 77 per cent.; while in the next largest orders, Cruciferæ, Scrophulariaceæ, and Gramineæ, the proportions are very close. A marked discrepancy is shown in the almost entire absence in Guada-

lupe of Cyperaceæ, Blygonaceæ, Rosaceæ, and Liliaceæ. The more common plants of the island are *Erodium cicretarium*, a common weed of Europe, a pine common to Southern California, a juniper common in California, a cypress similar to a Mexican species, a small oak common throughout California, and a palm, 40 feet high, whose fruit is edible. The vegetation of this island is not a derived one from California or any other region by any process of conveyance or selection, but it is an integral part of the flora of California, contributing beyond its measure toward the completion of that flora, and giving some hints as to the close connection that may, at some time, have existed between it and others more remote."

AGRICULTURE AND RURAL ECONOMY.

A *résumé* of progress in Agricultural Science would properly include, first of all, a reference to the Agricultural Experiment Stations, since it is in these institutions that by far the largest part of the research in this branch of science is carried on.

It is in Europe, and especially in Germany, that the experiment stations are most fostered. There are at this date some forty experiment stations proper in active operation within the limits of the German Empire, and twenty-two in other European countries. Besides these, there are between twenty-five and thirty laboratories and other establishments supported by schools, societies, or private individuals, and devoted to researches in agricultural science.

But one or two new experiment stations have been actually established in Europe since our last annual report. Four more have, however, been projected, and we shall doubtless hear of their actual establishment, as we have of the organization of some projected during previous years. Among the latter, by the way, is the one in Alsace-Lorraine, the province lately acquired from France by Germany. It is worthy of note that among the means adopted by Bismarck to reconcile and improve this new territory have been the establishment of a university at Strasburg and an experiment station at Rufach.

In the United States some hopeful beginnings have been made in this direction. The Bussey Institution of Harvard

University, though not an experiment station in name, is, under the direction of Professor Storer, proving itself to be one in fact. The movement toward the establishment of an experiment station in Connecticut, which was commenced two years ago, has resulted in the organization of a station at Middletown, in connection with the Wesleyan University, and under the direction of Professor Atwater.

Turning now to researches in agricultural chemistry, we notice that Knop has continued the series of studies on the absorptive power of soils in which he has been engaged for several years. His later results accord with his previous ones in indicating that the absorption of ammonia and potash increases with the amounts of three separate factors, "sesquioxide silicates" (of alumina and iron), "released silicates" (products of weathering), and sesquioxide of iron. These results are confirmed by investigations of Seiler and Frey. The same subject has also been investigated by Pillitz and Eichhorn. The latter chemist has tested the effect of zeolitic minerals in the soil upon the absorption of ammonia and potash. His experiments accord with the view for some time held that these hydrated silicates are most efficient factors of such absorption. The near relation of these to Knop's "released silicates" shows that the views of Eichhorn and Knop are not widely divergent. It should be added that the efficiency of sesquioxide of iron in absorption of alkalies is probably less than Knop has formerly supposed.

Fittbogen has studied the effects of various chemicals on nitrification in peat. He found the formation of nitric acid to be favored by carbonates of potash and lime, by lime, and by magnesia, and to be retarded by sulphuric acid, sulphate of lime, and sand. The formation of ammonia was greatest in confined air without chemicals, and was hindered by the above compounds.

Simon claims to have shown that humic acid absorbs nitrogen from the air with the formation of humate of ammonia, which is soluble in water. In this view peat and muck would be valuable, not merely as amendments and for the fertilizing material they contain, but also as purveyors of atmospheric nitrogen to the soil.

Storer has published some most valuable investigations

"On the Importance as Plant-food of the Nitrogen of the Soil," which enforce and, in part, explain the fact that the nitrogen of vegetable mould—the organic nitrogen of the soil—is under certain conditions available as food for plants.

Storer has also conducted a very interesting and important series of field experiments on the effects of different fertilizers on a soil which may be taken as a type of the light soils overlying gravelly drift that are common in New England. Potash proved more efficient than phosphoric acid or nitrogen, thus showing that the land stood most in need of potash. Indeed, in some cases, in this naturally sterile soil, phosphoric acid proved actually injurious to crops. Storer thinks this ill effect is due to the inability of the young seedling to endure excess of phosphoric acid in absence of needful supplies of other plant-food, and suggests as a new reason the higher value of superphosphates, that the soluble phosphoric acid is more uniformly diffused through the soil, so that no hurtful excess can come in contact with the roots of the plant.

A number of cases of poisoning of crops by ammonium sulphocyanate are reported in Europe. This compound sometimes occurs in the ammonia salts which are made at gas-works and used for fertilizers. It is recommended to test all fertilizers which may contain these salts for ammonium sulphocyanate.

That the subject of fertilizer analysis is receiving increased attention in this country is evinced by the reports of the chemists of Boards of Agriculture and of inspectors of fertilizers of various states. The reports of Professor Johnson, of Connecticut, Professor Goessmann, of Massachusetts, and of the inspectors of fertilizers of some of the Southern States, contain much timely information, and are exerting a great and salutary influence upon the trade in fertilizers.

Under the head of Vegetable Physiology, we note some very interesting water-culture experiments, by Fittbogen, on the quantity of nitrogen needful as food for the maximum development of the oat plant, which show the relation between the amount of nitrogen supplied and the yield of straw and seed, and accord with the results of other observa-

tions in showing that lack of nitrogen diminishes not only the whole crop, but also its percentage of nitrogen, and that the straw in this case suffers more than the seed. We have space for only the briefest reference to the interesting studies of Lehmann on the compounds of nitrogen best adapted to the nutrition of plants; by Schloessing on the absorption of ammonia by plants; by Bretschneider and others on the nutrition of sugar-beets; by Mayer and Wolkoff on the respiration of plants; and by Fittbogen on the evaporation of water from the oat plant.

The subject of the nutrition of domestic animals, or, to speak more generally, that of animal physiology, has been actively studied during the past year by feeding experiments in the experiment stations and elsewhere.

Among the more important investigations published are those of Wolff, Stohmann, Kühn, Märcker, Schulze, Fleischer, Hoffmeister, Heiden, Voit, Weiske, Wildt, and Pott.

Among the subjects investigated have been the digestion of different foods by different animals; the effect of fodder on milk production, the functions of the ingredients of foods, as the albuminoids, carbohydrates, and fats, in the formation of flesh and fat, and in the production of animal heat and muscular force.

The results of the year's work are not characterized so much by the discovery of new principles as by the confirmation and elucidation of those previously propounded.

For instance, one of the important principles brought out by the late German researches is that the carbo-hydrates, as starch and sugar, or easily digestible foods rich in these, as potatoes, when fed in considerable quantities with coarse foods, as hay and straw, decrease the digestion of the latter, while albuminoids or concentrated foods rich in these have no such effect. This is very strikingly exemplified in feeding experiments by Wolff, Märcker, Schulze, and Stohmann. So, likewise, the principle that a part of the woody fibre of plants, to wit, the cellulose, is digestible by ruminants and even horses is confirmed by several experiments of the same chemists.

The question from what ingredients of the food the fat in the body is made up is still hotly discussed, one main point in the controversy being whether the fat formed in the body,

other than that coming from the fats in the food, is formed from albuminoids or carbo-hydrates. The general drift of opinion is away from the old theory of Liebig that the fats are formed from (carbo-hydrates) sugar and starch, and toward the view advanced by Voit that the albuminoids of the food are the sources of the fats in the body. This latter opinion is strengthened, though not confirmed, by late researches by Weiske and Wildt.

PISCICULTURE AND THE FISHERIES.

The Fisheries.—We are without the data necessary for a summary, or a general expression of the results of the fisheries of the world at large, for 1875; but for the United States we have to record that the shore and lake fisheries have furnished large yields; although, in view of the continued increase in the number of nets and in the force of men necessary to work them, it may be questioned whether there has not been an actual diminution in the supply of fish at certain points. It is a well-established fact that stations for taking the whitefish of the lakes are readily exhausted, and that given localities become poorer and poorer successively, until, in a comparatively few years, they very greatly decrease in value as fishing stations. In this connection the measures, to be described hereafter, for renewing the supply by artificial propagation are of the utmost importance.

The Atlantic shore fisheries, for such species as the scup, sea-bass, etc., have been poorer than usual; while the catch of shad, especially on the whole southern coast, as far east as the Chesapeake Bay, was much less than for many years past. On the contrary, farther east—in the Delaware, Hudson, and Connecticut—the number taken has been unusually large. The explanation of this is found, by some, in the occurrence of a very late spring, with a high, cold state of the water, which is thought to have deterred the fish from entering the southern rivers, and probably caused them to extend their migrations farther to the east.

The mackerel fishery for the year has also been inferior to that of the previous season, while that of the cod has been about as usual. The menhaden fishery, on the eastern coast, is now rapidly becoming one of the most important

elements in this branch of industry, and was prosecuted with much vigor and with a very large yield. In 1874 three and a half million gallons of oil were made from 492,000,000 fish. The catch for 1875 was over 565,000,000, valued at $12,650,000.

Within the last few years large numbers of menhaden have been put up in tin cans, prepared in oil like sardines, and known by the various names of American sardines, ocean trout, shadines, etc., proving very palatable, even to those who are familiar with the oily, rank flavor of the fresh fish, and in many places replacing the sardines on account of their much cheaper price.

Some idea of the importance of the fisheries of the United States may be gathered from the statistics of the returns made to the port of Gloucester, Massachusetts, for 1875, the total catch amounting to 177,473 quintals of Bank cod-fish, 185,758 quintals of Georges cod-fish, nearly 10,000,000 lbs. of halibut, etc.; the total value amounting to $2,-905,994. This does not include the product of the shore fishing.

Another illustration of the same kind is furnished by a table of the consumption of fish brought to the Washington market, as shown by the report of the fish inspector of that city. The whole number of fish inspected in 1875 amounted to a little over 7,000,000 lbs., principally shad, herring or alewives, and striped bass—nearly all having been taken in the Potomac River and Chesapeake Bay. This, it may be remarked, is a considerable diminution as compared with the yield of 1874, which amounted to nearly 11,000,000 lbs., the difference being due to the very much smaller number of shad and herring taken, as already referred to.

For many years past there has been a decline in the whale-fishery, the low price of oil, in consequence of the competition of petroleum, not warranting the outlay and expense. Partly in consequence of the exhaustion of the accumulated stocks of oil, the prices have recently improved, and many of the old vessels that had been laid up in New Bedford, Edgartown, and elsewhere, were refitted and sent out on voyages. From the "Annual Review" of the whale-fishery, for 1875, by Messrs. Bartlett & Sons, we learn that the number of vessels engaged January 1, 1876, is 169, against 163

on the 1st of January, 1875. The number of vessels at sea, January, 1876, is 137, to 119 in the beginning of 1875, showing, therefore, an addition to the fleet actually on the water of 18 vessels.

The average catch of the Right whale fleet amounted to 1384 barrels of oil, and 14,900 pounds of whalebone, being the largest catch for any year since 1850.

Sperm-whaling has been but moderately successful, the average catch being 333 barrels in the Indian Ocean, and 223 barrels in the North and South Atlantic. The constitution of the whaling fleet for 1876 is given as 77 vessels in the North and South Atlantic, 15 in the Indian Ocean and New Holland, 13 in New Zealand, 23 in the Pacific and Off Shore ground, 18 in the North Pacific, and 4 at Cumberland Inlet. The total receipt of oil in the United States in 1875 was 42,617 bbls. of sperm-oil, and 34,594 bbls. of whale-oil, with 372,302 lbs. of whalebone.

The average price of sperm-oil for 1875 was $1 60¼ per gallon; of whale, 65½ cents; and of bone, $1 12¾ per pound. Of the fleet employed in the whale-fishery, by far the greater number of vessels came from the district of New Bedford, including New Bedford, Fair Haven, Dartmouth, Marion, and Westport, the aggregate being 125 vessels out of 169, just referred to.

The Newfoundland seal-fishery, which early in the season threatened to be almost a failure, improved somewhat later, and the average catch was perhaps equal to that of 1874. The great decrease of the catch in 1874 as compared with 1873 was a subject of much solicitude to the Newfoundland government, the same condition applying to the Greenland seal-fisheries also, and the enactment of some international measures has been very strongly urged for the protection of this interest. One cause of the rapid diminution appears to be due to the early date at which the pursuit is commenced, the mothers being killed by the sailors before the young are old enough to shift for themselves. As the two principal nations interested in this trade are Great Britain and Norway, negotiations have been in progress between them to fix upon a date before which it shall be unlawful to prosecute the business, the opening day proposed by Great Britain being the 5th to the 8th of April, while Norway insists upon the 1st of

the month. It is thought that probably a compromise will be made on the 3d to the 5th.

The United States is but little interested in this question, having scarcely any participation in the catch on the Atlantic coast.

The fur-seal fisheries of the Pacific coast, restricted as they are by law, have been about the same as heretofore, the full complement of 100,000 having been taken by the Alaska Commercial Company on the islands of St. Paul and St. George, leased to the company by the United States. In addition to this number, it has been estimated that 10,000 are captured elsewhere on the coasts of South America and Siberia. The capture of seals in the Southern Pacific has been greater than usual, several large cargoes having been brought in from the Shetland Islands, South Georgia, etc., of very superior quality.

Fish-Culture.—This subject has received greatly increased attention during the year 1875, in consequence of the growing interest felt in stocking our rivers and lakes with new varieties of valuable food fishes, or in restoring others to depleted waters. Nearly all the states now have Commissioners for this purpose, and their action is to a certain extent concentrated and harmonized through the United States Fish Commission.

Since our last report several states have appointed such commissions for the first time; and the reports as published of the operations of the different commissions furnish a gratifying proof of energy and success in this direction.

The operations of the United States Fish Commission have been carried on on a much larger scale than in previous years, and bid fair very soon to make their impression upon the food supply of the country, the number of shad placed in public waters having amounted to nearly eleven millions, and of California salmon nearly nine millions. No distribution has yet been made of the eastern salmon, or of the land-locked salmon, although a large number of eggs of both have been obtained, as the proper time has not yet arrived. Several millions of eggs of whitefish of the lakes have also been obtained and hatched out.

An important forward step on the part of the Commission has been the importation of a large number of young carp

from approved ponds in Germany. The want has long been felt of a fish that will thrive in the warmer waters of the United States, where trout and other similar kinds can not be sustained. In the carp we have a fish capable of withstanding any reasonable elevation of temperature, and one that, being a vegetable feeder, will find sustenance and grow rapidly in ponds and other limited bodies of water. Throughout Europe this fish occupies among the finny tribe the position of poultry among birds, and is almost as easily kept; and when the supply obtained by the United States Commission is large enough for distribution, there is no doubt that it will be eagerly sought for.

The State Commissions have also been doing their part in the multiplication of food fishes, the New York Commission, under the direction of the well-known Seth Green, having hatched out many millions of shad in the Hudson River, as also large numbers of brook and salmon trout. The efforts in the direction of multiplying black bass, pike, perch, etc., have also been continued.

Massachusetts has also continued the work of propagating shad in the Merrimac River. On the great lakes the multiplication of whitefish, has been conducted on a very extensive scale by several states, especially by Michigan. A special hatching-establishment has been erected at Detroit for the whitefish, and now contains about seven millions of eggs. A somewhat less number is also in process of development at the Canadian establishment on the opposite side of the river. Ohio has established several hatching-houses, and has a considerable number of whitefish and other species, to be distributed eventually to the waters of that state.

For information in regard to the minuter details of these various operations, reference may be had to the article on "Fisheries," page 465.

A good deal of the interest felt in the subject of fish-culture is due to the annual meetings of the American Fish-Culturists' Association, in New York, usually about the middle of February, where the several State Fish Commissioners and the principal fish-culturists of the country confer in regard to their mutual interests.

An annual convention of State Fish Commissioners is

usually called by the United States Commissioner, when the general policy in regard to the kinds of fish to be specially treated on a large scale, and the most suitable places for their introduction are established. This meeting for 1875 was held in New York about the time of the annual meeting of the Fish-Culturists' Association, and that for 1876 will probably be called at Philadelphia some time during the period of the International Exposition.

INDUSTRIAL STATISTICS.

The condition of the *Iron* producing and manufacturing industries of the country, although presenting certain favorable features, is at the time we write much the same as at the close of the previous year. In attempting to present a statistical *résumé* of these important industries, we are confronted with the same difficulty to which we referred in our last; namely, the impossibility of securing accurate returns of yearly production until long after the close of the year; while estimates of probable production, owing to the magnitude of the industries, are more or less untrustworthy. The Statistical Report of the Secretary of the American Iron and Steel Association, just published, and containing detailed statistics of the American iron trade up to January 1st, 1875, will enable us to bring forward our figures of last year's *Record* to the date above named, and to replace our estimated values for the year 1874 with ascertained results. We are likewise able to supplement the association's statistics with certain facts in relation to the same subject, and which afford information of interest with regard to pig-iron production up to September 1st, 1875.

The figures published by the association are, for pig-iron, as follows: The total production of the year 1874 was 2,689,413 net tons, against 2,868,278 net tons in 1873, and 2,854,558 tons in 1872; showing a decrease of 178,865 net tons as compared with 1873, and of 165,145 tons as compared with 1872. Notwithstanding this decrease, the production of 1874 was much larger than was generally anticipated; much larger than the partial returns made to the association, and from which our estimated values, as published in last year's *Record*, were obtained, indicated.

This unexpected result the secretary explains by pointing

to the fact that the extraordinary impulse given to the iron-producing industries of the country during the years immediately preceding the panic called into existence a large number of new furnaces, many of which were of the largest size and constructed upon the most approved plans. The furnaces which made 2,854,558 tons of iron in 1872 were mostly small, and, owing to the excitement and recklessness of those times, not so managed as to produce the best results. "When we consider," says the secretary, "that the lessened number of furnaces which made 2,868,278 tons in 1873 included all the large and improved new furnaces, and when we consider that there were almost as many furnaces in blast in 1874 as in 1873, that as a rule the best furnaces in the country were running in 1874, while the poorest stood idle, and that, from motives of enforced economy and by reason of increased skill, the management of most of the furnaces in blast in that year was such as to produce the largest possible yield, we need no longer wonder that the production of 1874 was only 178,865 tons less than the product of 1873." The number of new furnaces completed in 1874 was 38, against 50 in 1873, and 41 in 1872. No less than 46 stacks are reported as being in course of erection in 1875, while other new furnaces are projected. The district showing the greatest increase of production during 1874 was the miscellaneous coal and coke district of Ohio. The district showing the greatest decrease during 1874 was the Lehigh anthracite region of Pennsylvania. Utah Territory made her first pig-iron in 1874—200 tons of charcoal. After a long rest, Oregon, with one furnace, made 2500 tons of charcoal iron in 1874. Texas made 1012 tons of charcoal iron in 1874. South Carolina, with eight furnaces, and Minnesota, with one furnace, made no iron in that year.

The total imports of pig-iron into the United States in 1874 were 61,165 net tons, against 154,708 net tons in 1873, 295,967 net tons in 1872, and 245,535 net tons in 1871.

The total exports of pig-iron from the United States to all countries in 1874 were 16,039 net tons, against 10,103 net tons in 1873, and 1477 net tons in 1872.

The following table affords an oversight of the growth of the pig-iron branch of the iron trade of the United States from 1854 to 1874, compiled from the association's statistics:

Years.	Anthracite.	Charcoal.	Bituminous Coal and Coke.
1854	339,435	342,298	54,485
1855	381,866	339,922	62,390
1856	443,113	370,470	69,554
1857	390,385	330,321	77,451
1858	361,430	285,313	58,351
1859	471,475	284,041	84,841
1860	519,211	278,331	122,228
1861	409,229	195,278	127,037
1862	470,315	186,660	130,687
1863	577,638	212,005	157,961
1864	684,018	241,853	210,125
1865	479,558	262,342	189,682
1866	749,367	332,580	268,396
1867	798,638	344,341	318,647
1868	893,000	370,000	340,000
1869	971,150	392,150	553,341
1870	930,000	365,000	570,000
1871	956,608	385,000	570,000
1872	1,369,812	500,587	984,159
1873	1,312,754	577,620	977,904
1874	1,202,144	576,557	910,712

The nearest approximation to an estimate of the possible production of pig-iron during the year 1875 may be made from the accompanying data recently published by the *American Manufacturer*, of Pittsburgh, Pennsylvania. The figures have been compiled from returns received from 95 per cent. of the whole number of furnaces, and show the number of stacks in and out of blast in nearly every section of the country on the 1st of September, 1875, compared with those which made similar reports to the same journal at the same period of 1874. The number of furnaces reporting is as follows: In 1874, 575 stacks; in 1875, 664 stacks. Of these there were in blast, in 1874, 348 stacks, with a weekly capacity of 51,439 tons; in 1875, 289 stacks, capacity 47,008 tons. Out of blast, 1874, 227 stacks, weekly capacity 39,089 tons; 1875, 375 stacks, capacity 53,803 tons. The whole number of finished stacks in the country at the time of this report is estimated at 700. The above figures indicate that the production of 1875 will be much below that of 1874. We may hazard the estimate that it will not exceed 2,000,000 tons.*

[* Since the preparation of the foregoing summary, Mr. Secretary Swank has published an *estimate* of the pig-iron industry for the entire year 1875,

The following table shows the production in net tons of all forms of rolled iron produced in the United States in 1874, compiled from the association's statistics. This table, arranged to show the production by states, includes bar, band, hoop, plate, sheet, angle, girder, beam, boat, guide, rod, and bridge iron and rolled axles. All forged iron, such as anchors, anvils, hammered axles, cranks, ships' knees, etc., is carefully excluded, because of the impossibility of learning, even approximately, the amount of iron hammered or forged

States.	Bar, Angle, Bolt, Rod, and Hoop Iron.	Plate and Sheet Iron.	Cut Nails and Spikes.	Iron and Steel Rails of all Sizes.	Total Rolled Iron.
Maine	3,994	....	....	14,650	18,644
New Hampshire	300	....	....	....	300
Vermont	....	....	....	10,400	10,400
Massachusetts	40,324	6,592	28,819	24,765	100,500
Rhode Island	7,170	....	3,446	....	10,616
Connecticut	11,921	....	....	....	11,921
New York	76,590	4,000	5,949	46,979	133,518
New Jersey	24,645	2,256	27,643	3,537	58,081
Pennsylvania	343,632	120,098	75,151	259,288	798,169
Delaware	6,860	4,958	....	....	11,818
Maryland	8,455	12,428	....	48,008	68,891
Virginia	11,086	....	5,602	....	16,688
Georgia	1,406	....	....	8,061	9,467
Alabama	1,000	....	....	....	1,000
West Virginia	1,609	....	54,201	522	56,332
Kentucky	18,239	5,120	5,121	6,068	34,548
Tennessee	1,573	....	660	13,693	15,926
Ohio	105,413	5,143	27,253	82,561	220,370
Indiana	7,376	....	7,514	20,617	35,507
Illinois	2,500	2,240	4,250	125,103	134,093
Michigan	4,207	1,553	....	2,448	8,208
Wisconsin	275	....	....	29,680	29,955
Missouri	1,500	10,870	....	24,017	36,387
California	9,205	....	....	7,016	16,221
Texas	....	....	....	2,000	2,000
Total	689,280	175,258	245,609	729,413	1,839,560

based upon partial returns made to the association's office. The more important figures of this estimate we add herewith to supplement our preceding statements, viz.:

Total pig-iron production for 1875 (estimated)..	2,068,696	net tons.
Decreased production as compared with 1874 ...	620,717	"
Whole number of furnaces in 1875.............	713	"
Number in blast December 31, 1875............	345	"
" out of blast " "	368	"

—*Ed.*]

in the vast number of machine-shops, locomotive works, marine-engine works, and similar establishments throughout the country.

The total production of all rolled iron in 1874, Bessemer rails included, was 1,839,560 net tons, against 1,966,445 net tons in 1873, a decrease of only 126,885 net tons. This decrease was all in rails. In the following table is presented a summary of the production of all forms of rolled iron in the United States from 1864 to 1874 inclusive.

Years.	Rails.	Other Rolled Iron.	Total.
1864	335,369	536,958	872,327
1865	356,292	500,048	856,340
1866	430,778	595,311	1,026,089
1867	462,108	579,838	1,041,946
1868	506,714	598,286	1,105,000
1869	593,586	642,420	1,236,006
1870	620,000	705,000	1,325,000
1871	775,733	710,000	1,485,733
1872	1,000,000	941,992	1,941,992
1873	890,077	1,076,368	1,966,445
1874	729,413	1,110,147	1,839,560

The total production of rails of all kinds in the United States in 1874 was 729,413 net tons, against 890,077 tons in 1873, 1,000,000 in 1872, and 775,733 tons in 1871. About one-half of the total rail product of 1874 was made up of old rails re-rolled. The total importation of new rails in 1874 was as follows: Of iron, 7796 net tons; of steel, 100,486 net tons: total, 108,282 tons. The probable consumption of rails during the year was therefore 837,695 net tons, against 1,148,850 tons in 1873, and 1,530,850 tons in 1872.

The eight completed Bessemer works in this country, although not fully occupied during the year 1874, turned out, according to the figures of the association, a greater product than that of 1873. The production of Bessemer steel rails in 1874 was 144,944 net tons, against 129,015 in 1873—a gain of 15,929 tons. The production of Bessemer steel rails in this country since 1867, when they were first made upon orders, has been as follows in net tons:

Year.	Tons.	Year.	Tons.
1867	2,550	1871	38,250
1868	7,225	1872	94,070
1869	9,650	1873	129,015
1870	34,000	1874	144,944

The total quantity of pig-iron, converted by the Bessemer or pneumatic process was 140,404 net tons in 1872, 183,534 tons in 1873, and 204,352 tons in 1874. The secretary estimates the probable production of Bessemer rails in the United States during the year 1875 at fully 250,000 net tons.

The following additions to the Bessemer works in the United States in 1875 are reported: The Edgar Thompson Steel Company, Limited, made its first blow on August 26th last; started its blooming-mill on Friday, August 27th; and rolled its first rail on Wednesday, September 1st. The works at once went into full operation. The Lackawanna Iron and Coal Company followed on the 23d of October. This company makes the tenth that is now engaged in making Bessemer steel rails in this country, and we learn that the foundations for the Bessemer plant of the Vulcan Iron Works at St. Louis have lately been laid.

The secretary of the association furnishes, furthermore, the following statement of the quantity of Bessemer ingots made in Great Britain in gross tons: In 1870, 215,000 tons; in 1871, 329,000 tons; in 1872, 410,000; in 1873, 496,000; and in 1874, 540,000; and draws attention to the fact that when the three new Bessemer establishments are all put in operation—making eleven in all—the capacity to produce Bessemer steel will be as great in this country as it now is in Great Britain.

The following table shows the production of steel, other than Bessemer, in this country during the past ten years in net tons:

Year.	Tons.	Year.	Tons.
1865	15,262	1870	35,000
1866	18,973	1871	37,000
1867	19,000	1872	38,000
1868	21,500	1873	50,000
1869	23,000	1874	47,481

The production of open-hearth, or Siemens-Martin steel, is steadily increasing in this country. In 1872 it amounted to 3000 net tons; in 1873 to 3500 tons; and in 1874 to 7000 tons.

We compile, finally, from the foregoing statistics of the production of pig-iron, rails, bar-iron, steel, etc., in the United States in 1872, 1873, and 1874, the following table of the ag-

gregate production of iron and steel, embracing the different branches of the iron trade:

Products—Net Tons.	1872.	1873.	1874.
Pig-iron	2,854,558	2,868,278	2,689,413
All rolled iron, including rails	1,941,992	1,966,445	1,839,560
All rolled iron, including nails and excluding rails	941,992	1,076,368	1,110,174
Rails of all kinds	1,000,000	890,077	729,413
Bessemer steel rails	94,070	129,015	144,944
Iron and all other rails	905,930	761,062	584,469
Street rails	15,000	9,430	6,789
Kegs of cut nails and spikes	4,065,322	4,024,704	4,912,180
Merchantable Bessemer steel other than rails	16,430	27,985	31,635
Total Bessemer steel	110,500	157,000	176,579
Crucible cast steel	27,260	32,786	34,128
Open-hearth steel	3,000	3,500	7,000
All other steel	7,740	13,714	6,353
Blooms from ore and pig-iron	58,000	62,564	61,070

From the *Engineering and Mining Journal*, which claims to have devoted especial care to the collection of authentic statistics upon this subject, we give the following statement of the coal production of the United States for the year 1874. The totals are in net tons. During the year 1874 there was produced—

Anthracite	24,281,471
Bituminous	25,248,684
Lignite	1,217,020
Total	50,747,175

Or 45,209,980 gross tons.

The great strike in the anthracite region during the past year, and which was finally terminated by the complete submission of the miners to the operators' terms, was one of the most obstinately conducted and disastrous in its results that have ever taken place in the country.

At the time of writing we have no data at hand upon which to base an estimate of the total coal production of the past year. The same journal *estimates* the production of anthracite during 1875 to have been 21,441,000 gross tons. The technology of this subject will be found in its appropriate place.

The statement of the production of the precious metals in the United States shows that the gold yield is gradually de-

clining, while that of silver increases. The twenty-six years from 1848 (the first year of a gold yield in California) to 1873 are embraced in the statement.

During this period the average annual gold yield was $50,800,000, while the average annual yield of silver was $13,300,000. The highest gold production was between the years 1851 and 1857, when it exceeded $55,000,000 a year. The highest annual silver production was in 1873, when it reached $37,750,000. With the exception of one or two years, the gold production has steadily decreased from 1857, while the silver production has steadily increased since 1859. About the year 1873 the proportion of the one about equaled that of the other. The annual statement of the production of the precious metals in the states and territories west of the Missouri River (including British Columbia) for the year 1874 shows an aggregate yield of $74,401,065, being an excess of $2,142,362 over that of 1873. The discovery of the great "bonanza," or ore-body, on the Comstock lode, during the past year, will doubtless swell the figures of silver production enormously. The Annual Report of the Director of the Mint to the Secretary of the Treasury enables us to bring forward the statistics of the domestic production of the precious metals to June 30, 1875. For the year ending with the date just given, the director gives the following values, viz.:

Arizona...........	$1,000,000	New Mexico	$1,000,000
California.........	17,000,000	Utah..............	6,844,570
Colorado..........	5,472,000	Oregon............	1,665,000
Idaho.............	2,500,000	Wyoming Ter.......	250,000
Montana..........	4,119,852	Washington Ter....	300,000
Nevada...........	31,795,193	Total.........	$71,946,615

In view of its growing importance, it may not be amiss to notice in our statistical summary the condition of the American Silk Industry, as presented in the report of the Secretary of the Silk Association of America. This document embraces comprehensive facts and figures, bringing up the statistics of this growing industry to December 31, 1874. From these statistics we learn that thirteen states manufactured silk goods during 1874, distributed as follows in firms and corporations: New Jersey, 42; Connecticut, 21; New York, 70; Massachusetts, 11; Pennsylvania, 23; California, 3;

Ohio, 3; Illinois, 2; and New Hampshire, Vermont, Maryland, Missouri, and Kansas, each 1; total, 180. The total number of operatives employed was 14,479; of whom 4086 were males above the age of 16; 1048 were males under 16; 6858 were females over the age of 16; and 2478 females under the age of 16. The wages paid amounted to $4,497,319; the value of the capital invested and employed was $14,708,184; and the total value of the year's production amounted to $20,082,482.

We have at hand the detailed statement of the exports and imports of the United States for the fiscal year ending June 30, 1875, issued by the chief of the Bureau of Statistics; from which it appears that our total imports during that period were valued at $553,906,253, a decrease of $41,954,995 as compared with those of the previous year. Our exports during the same period were valued at $643,081,433, a decrease as compared with the previous year of $49,957,621.

Railroads.—For the year 1875 we may record, as far as ascertained, the construction of 1483 miles of new railroads in the United States. Some additions to these figures will possibly have to be made, but when returns are complete the total for the past year will hardly exceed 1500 miles; showing a decrease of about 25 per cent. as compared with the figures of 1874, of over 60 per cent. with those of 1873, and of over 80 per cent. as compared with the figures of 1872. Our estimated figures of new construction for 1874, published in last year's *Record*, require but a trifling correction, as will be apparent from the appended statement:

Mileage constructed in 1872 (ascertained)	7340
" " in 1873 (")	3833
" " in 1874 (")	2025
" " in 1875 (estimated)	1483

The most important lines completed this year are the New York and Canada, along the west shore of Lake Champlain, and an extension of the Southern Pacific in Southern California; neither of these is very long.

The leading event in railroad business during the past year was the long competitive contest begun by the Baltimore and Ohio and the Pennsylvania Railroad Companies in March, 1875, and continued between all the lines from the East to the Northwest until September. The establishment

of the Southern Railway and Steamship Association in October last, for the purpose of regulating competitive business in the Southeast, may prove to have been the most important event of the year. During the year, likewise, the State of Missouri established a Railroad Commission, and enacted severe laws regulating rates. The State of Minnesota repealed its laws regulating and limiting rates minutely, and substituted a Commission with power only to investigate and recommend. The Erie Railway Company was added to the long list of American roads unable to pay interest on their funded debt. Of nearly $500,000,000 of railroad bonds which had ceased to pay interest before the close of 1874, payment was resumed only in one or two cases. Several railroads were sold under mortgage during the year; arrangements were completed to obviate a foreclosure in several cases, but a large number of companies have not yet completed any settlements with their creditors. Railroad traffic was generally lighter than in 1874, and rates lower; expenses were likewise somewhat lower.

In railroad improvements perhaps the most notable events were a more extended application of Hall's Electric Signal system, especially on Boston railroads; the introduction of the well-known Saxby & Farmer interlocking signal and switch system—much used in England—on the Pennsylvania Railroad; and a system intended to effect the same objects by the New York Central and Hudson River Railroad, the invention of two officers of that road, Messrs. Toucey and Buchanan. The Saxby & Farmer system has been in operation upon the principal railroads of England, with such eminent satisfaction that by Act of Parliament its use has been declared obligatory on all new lines in that country. The following brief comments, from one of our leading journals, will convey some idea of the merits of the system: "Unless an engine-driver deliberately shuts his eyes to prominent danger signals, and intentionally dashes his train to destruction, it would seem that with the Saxby & Farmer mechanism an accident is hardly possible. The switch-tender is utterly precluded from making a blunder, either in signals or in locking or setting his points. The very worst he can do is to neglect his duty altogether, and the only result arising therefrom would be a temporary stoppage of the trains. He can

not shift points during the passage of a train and so send the rear cars off the track, nor can he easily signal a line clear until such is the case. The characteristic feature of the Saxby & Farmer system is its absolute positiveness." For the Toucey & Buchanan system merits no less positive are claimed.

The past year has witnessed, likewise, a considerable extension of the employment of continuous power-brakes. On both sides of the Atlantic an unusual degree of interest was manifested upon this point; in England, indeed, the government, with commendable appreciation, has referred the problem to a Royal Commission for exhaustive examination and report. The conclusions of this body have not yet transpired. In this connection we may note that the hydraulic system, as distinguished from the atmospheric, appears to be steadily gaining ground. With the several forms of atmospheric brakes in use, despite their great merits, the great complexity of the apparatus, and its liability to become deranged in consequence, are serious objections, which in the hydraulic system—certainly in the best representatives of this class—are largely obviated. It is of interest, therefore, to remark that the record made during the past year by the Henderson Hydraulic brake—the pioneer in this field, to which we made brief allusion in our last volume—was as satisfactory as the warmest advocates of the system could have desired. Assuming this particular brake to be the representative of its class, it may be safely affirmed that it has demonstrated the hydraulic system to be prompt in action, reliable, requiring little care and no skilled attention, advantages which can not fail ultimately to tell strongly in its favor.

Steel and steel-tired car-wheels found some favor during the past year as substitutes for the prevailing chilled cast-iron ones. There was evident some reaction against the use of steel for locomotive fire-boxes. The tendency to use heavier locomotives on railroads with heavy traffic has continued. The use of separate tracks for freight on the New York Central and Hudson River Railroad has made a material saving in the movement of freight, though the traffic has not been sufficient to crowd the old tracks. The New York railroads carried more than ever before of the grain between Lake Erie and tide-water, though canal rates were never before so low.

The fiftieth anniversary of the opening of the first public railroad worked by steam was celebrated at Darlington, England, on September 27, 1875. On the same day, by a curious coincidence, a rolling-mill (at Stockton) began rolling rails for the first Chinese railroad, a charter for which has been granted to a company of Englishmen and Americans.

German railroads, at the beginning of the year, were authorized to increase their tariffs on freight (with the exception of certain necessaries of life) to the extent of not more than twenty-five per cent., on account of great reductions in profits through the rise some years before in wages and materials.

There was much discussion in France on the providing of railroads of local interest, the problem being to prevent such roads from injuring the business of existing roads, which have a government guarantee of interest on a large part of their capital.

The Railway Commission established in Great Britain, in 1874, as a species of court having jurisdiction over certain cases of differences between railroads and the community, and of railroads with other railroads, has heard and decided many cases during the past year, and has proved itself to be a valuable tribunal. One of the members is an old railroad manager (and is required by law to be an expert in railroad business), another is a lawyer, and the third a nobleman.

There has been a general stagnation in the work of railroad construction during the past year in almost all countries, with the exception perhaps of Russia.

The railway statistics of the world have been collaborated with considerable accuracy up to the close of the year 1874; at which date we may estimate the length of all the railways of the world, from the best sources of information at our disposal, to have been 173,237 miles, with 56,700 locomotives (having in the aggregate 1,134,000 horse-power), 103,700 passenger, and 1,356,000 freight cars.

An outgrowth of the numerous transportation schemes advocated at the last session of Congress was a government survey for a railroad from the Tennessee River to the Atlantic Ocean. The line in question is proposed as a cheap freight route for the grain and other produce of the Missis-

sippi Valley. The line surveyed begins at Guntersville, Ala., on the big bend of the Tennessee River, and runs in an almost direct line to its proposed terminus, the harbor of Brunswick, on the southeastern coast of Georgia. Its length is 412 miles.

The considerable progress made during the year toward the completion of the Underground Railway system in the city of New York, referred to in our last year's *Record*, is worthy of remark. The discussion of the rapid-transit problem, the necessity for some system of which has become imperative, culminated in the appointment by the Mayor of a commission empowered to select routes and decide upon plans. This commission, after an examination of numerous systems and designs, and full consideration of the subject in all its bearings, selected the following routes:

On the west side of the city, the present line of the Greenwich Street elevated railroad is to be continued up Ninth Avenue to the Harlem River. Another route is to be by Sixth Avenue to Fifty-ninth Street, and there to connect with the Greenwich Street road. On the east side, the road will pass up Third Avenue, or as an alternative up Second Avenue, to Harlem Bridge, and will have branches to the ferries and the Central Dépôt. The plan of road decided upon by the commission is an elevated structure. It is expected that these plans will be realized in practice before the end of the year 1876. During the past year, likewise, the councils of the city of Philadelphia granted the right to the Philadelphia Pneumatic Company, incorporated by act of Legislature, to construct, operate, and maintain a railroad with one or more tracks, to be located beneath the surface of Broad Street, and to extend therefrom to a number of the railroad dépôts. The purpose of the company, as expressed in the ordinance, is to improve and increase the facility, rapidity, and convenience of transit between the business portion of the city and the various railroad dépôts. Thus far, however, no steps have been openly taken to carry this project into effect.

We append, finally, to conclude our record of railroad events, a tabulated statement of accidents to railroad trains in the United States for one year ending with last December. For these statistics (as likewise for those of mileage)

we are indebted to our admirable contemporary, the *Railroad Gazette.** This accident table is the only one of the kind, published at home, for the whole country, and contains, probably, most of the accidents resulting in personal injury. For the year ending with December, the record is as follows:

	No. of Accidents.	Killed.	Injured.
January, 1875	131	10	96
February, "	211	11	186
March, "	122	17	73
April, "	60	9	67
May, "	54	6	43
June, "	61	23	67
July, "	73	33	50
August, "	114	27	110
September, "	116	50	182
October, "	88	12	74
November, "	87	24	97
December, "	84	12	62
Totals	1201	234	1107

Engineering.—The most important item in the province of *Engineering* is the inauguration of the difficult work of improving the channel of the Mississippi River at its mouth, so as to render the same a permanent thoroughfare to the Gulf of Mexico, by which the river ports will be opened to direct ocean traffic for vessels of the deepest draft. After much discussion of the rival merits of plans involving the building of canals (see last year's *Annual Record*), the subject was finally settled by an appropriation, at the last session of Congress, for the construction of a system of jetties and auxiliary works at the South Pass of the river. The plans adopted are those of Captain J. B. Eads, the constructer of the great steel bridge at St. Louis, under whose superintendence the work has been commenced, and considerable progress already made. By the nature of the contract, the work has been undertaken at the sole risk of Captain Eads and his associates, inasmuch as no payments are to be made by the government until certain stipulated depths of water have been secured and maintained. The act of Congress provides that

* For much of what is of value in the foregoing summary of railroad news we are under obligations to the courtesy of Mr. S. Wright Dunning, editor of the *Railroad Gazette.—Ed.*

when a depth of twenty feet shall have been secured a certain payment shall be made, and so on up to thirty feet; that twelve months after each of the prescribed depths has been secured a further payment shall be made, provided the same has been maintained during that time; and that $100,000 shall be paid annually during twenty years, for maintaining the works after construction, and for extending them if necessary, so as to keep the channel at the required depth. The plan of the work is remarkably simple. It contemplates the removal of the point where the sediment of the river is at present deposited, namely, in the shallow water at the entrance of the pass, farther out into the deep water of the Gulf, where filling up again by natural causes will be an indefinitely remote possibility. To accomplish this object, the banks of the pass will be extended, so as to carry the stream far enough out, by the creation of artificial walls within which the waters of the mouth will be confined, said walls being so proportioned in width to the quantity of water escaping as to produce an increased velocity of current, and thus force the stream to scour out for itself a channel of required depth. Extensive lines of jetties will therefore be constructed along the course of the moving waters, the jetties being simply dikes or levees under water which are intended to act as banks to the river, to prevent it from expanding and diffusing itself as it enters the sea. The greatest difficulties to be overcome were to devise means of creating these artificial walls, and making them secure and permanent upon the exceedingly unstable foundation of soft sediment, into which any works of stone would speedily sink and disappear. Piles alone, or crib-work, however firmly placed, would soon be undermined and swept away by the scour of the current. To meet these difficulties, Captain Eads builds the artificial walls of the river with broad, flat mattresses of willow-brush, securely lashed together and anchored to an interior row of piles. The preliminary work is the driving of piles along and inside of the line for the proposed structure. Meantime great mattresses of willow-brush are constructed, firmly locked together with cross-ties and pins. These mattresses are towed into position adjoining the piles, and fastened to them. If placed at night, by morning the deposit

of sediment from the current has so filled the interstices as to sink them so that they rest upon the bottom. Each mattress is not only fastened to others adjacent and to the piles, but it is anchored in its place by a layer of stone, and the sediment continues to gather in upon them until they become more solid and enduring than any part of the natural bank. When completed, the wall of mattresses will perfectly protect the row of piles from the current, while the piles in turn serve to hold the mattresses in position; and the whole will be finally covered with a firm stone paving. The outer ends of the walls, where they are exposed to the sea, will be constructed of broader and stronger mattresses, supporting solid and durable works. It will be the work of years to complete the whole structure; but its benefits will begin to be manifest directly, for the channel will rapidly deepen as fast as it is confined within the walls. It is calculated that these will have been so far completed at the close of 1875 that the largest ships ever seen in New York harbor can enter the South Pass at any time and proceed without delay to New Orleans. A board of eminent engineers, invited by Captain Eads, with the approval of the President, to examine and pass judgment upon his plans, has, after careful consideration of the subject in all its details, emphatically indorsed the feasibility of the undertaking.

The government operations at Hallett's Point for the removal of the obstruction to entering the East River by way of Long Island Sound are fast approaching completion. The work, which is under the superintendence of Captain W. H. Heuer, United States Engineer, was begun in 1869, and has cost up to the present time about $750,000. After a tedious labor of nearly six years, the task of excavation was completed about last July, and the secondary work of preparing for the grand blast is now going on. The excavation extends under two and a half acres of gneiss rock vertically stratified. Starting from a main shaft thirty-four feet below mean low water, ten main headings, sloping down to fifty-two feet below mean low water, have been extended out to an average length of 250 feet each. The height of these main headings varies from eight to twenty-two feet, with an average width of fourteen feet. From the main headings intermediate headings have been cut, and at uniform dis-

tances circular galleries have also been cut across the headings, forming a series of columns or piers at the points of intersection, by which the roof is supported. The work of demolishing the reef will consist in breaking up these piers and shattering the rocky roof. The boring of holes in the roof and the columns has been progressing for some months, a number of Burleigh rock-drills being employed for that purpose. Captain Heuer expects to complete the drilling about the last of January. The work of charging will then be commenced, and will probably occupy two months longer. The nitro-glycerine, which will be used for the explosion, will be placed in iron tubes, each of which will have a direct battery-connection, besides being connected with adjacent holes by means of a series of smaller tubes filled with the same explosive. When all is ready the water will be let into the excavation, and the whole series of charges exploded simultaneously by electricity. It is proposed to fire the mine on the Fourth of July, 1876.

At Flood Rock, likewise, the work of excavation was commenced last June. The same system will be pursued as at Hallett's Point, but the excavations will be much greater in extent, as the rock stretches out about 400 feet in two directions from the shaft. At the time we write, a shaft ten by forty feet in plan, and sixty feet deep, has been sunk, from the bottom of which tunnels will radiate until the whole reef shall have been undermined. Thus far but two tunnels have been started, which are in about twenty feet and thirty feet respectively. Only a commencement has been made, the survey being as yet incomplete. The reef embraces over six acres of area, and the time necessary to complete the work will depend entirely upon the action of Congress in making appropriations. The removal of the reef at Hallett's Point will materially lessen the dangers of the Hell Gate passage, and be a permanent advantage to commerce even before the second and more difficult enterprise is brought to a sucessful conclusion.

The government works at League Island Naval Station are being rapidly advanced. The buildings already erected, but not yet finished, are the Iron-plating shop, 270 by 85 feet, and which will be connected with the Naval Constructer's Department, and the Yards and Docks Building.

The latter is 230 by 65 feet, and is nearly finished. Opposite this will be the storehouse for steam-engineering, to be 400 by 500 feet, now being erected. In the rear of this is the engine-house, containing an engine of sufficient power to supply the entire power for the station; and near by the Fire Department house, with two steamers and a supply of hose ready for use. It is proposed to divide the entire island into squares of 400 by 200 feet, of which there will be sixty, used by the various departments for an infinite variety of uses. The floating-dock basin projected will be thirty-one acres in extent; a repairing basin will be thirty acres; a storage dock basin, seven acres; and a fitting-out basin, forty acres. The floating-dock basin will be on the Delaware side, and connected by numerous railroad tracks with various departments. The quay wall on the river front will have a water-depth of twenty-eight feet, while the river here is 2800 feet wide. The main avenue will be 125 feet wide; an avenue parallel with the river, eighty feet; and all other streets and thoroughfares, seventy-five feet. The plan comprises a system of floating-docks, combined with shallow basins and railroad tracks, for raising ships and taking them on shore, and by this means a large number of ships can be provided for at once. When all the dredging and digging is completed, there will be an aggregate of 155 acres of deep water. The area will be divided as follows: The Bureau of Steam Engineering will have nineteen acres' space; Coal Bureau, thirty-six acres; Bureau of Ordnance, twenty-four acres; Bureau of Provisions, eight acres; Bureau of Yards and Docks, seventeen acres; and the Marine Corps, twenty-one acres. When completed, the League Island Naval Station will be a yard as finely arranged and as convenient for the purpose as can be found in the world.

A commission of government engineers has lately made an investigation and report upon a permanent plan of reclaiming the alluvial lands of the Mississippi now subject to inundation. The total area of the bottom-lands is approximately 32,000 square miles, of which but a narrow strip along the main stream and its tributaries is open for cultivation; while it is affirmed that with proper protection against inundation from the river, and efficient drainage, no less than ten million acres of land of extraordinary fertility would be re-

claimed for cultivation. The Commission, in its report upon this subject, recommends the perfecting of the levee system. The diversion of tributaries, artificial reservoirs, cut-offs, and artificial outlets are declared to be impracticable. The report recommends that the Atchafalaya and the La Fourche be kept open, that the Plaquemine be reopened, if borings shall show it to be practicable, and that a general levee system be established which shall extend from the head of the alluvial basin to the Gulf, and shall include the valleys of the tributaries. The proposed levees will be of sufficient height and strength to resist the action of the water and to restrain the floods. The cost of the proposed improvement is roughly estimated at $46,000,000.

The degree of success that has attended the introduction of steam-power on the canals of the State of New York will be best appreciated by the perusal of the following extracts from a lengthy report of the State Engineer and Surveyor in response to a resolution of the Assembly, passed February 5, 1875, asking for information on the subject. At the close of an historical sketch of some length, the report has the following statements: "I am of the opinion that the question of economy and adaptability of steam as a motive-power on the canals of this state is removed beyond the sphere of experiment, and that ultimate and complete success now depends upon capital alone. When adverse interests shall be reconciled, when the continued success of the present steamers shall have convinced the timid and doubting capitalist, and when the facts already developed shall be more widely disseminated, and shall receive the credit to which they are clearly entitled, I feel sure that the general introduction of steam will proceed rapidly to a complete and successful accomplishment. The simple fact that under no circumstances likely to occur can steamboats be introduced more rapidly than the present horse-boats will disappear, should satisfy those who are interested in the latter, and who fear embarrassment from the change, that the transition may be effected without serious loss or inconvenience to them."

The subject of interoceanic communication across the American isthmus has received several important contributions. During the past year two government expeditions were at work upon preliminary surveys for a ship-

canal—one upon the route generally known as the Atrato and Napipi; the other upon the Chepo route, and upon a line nearly coinciding with that of the present Panama Railroad. The first expedition, under the command of Lieutenant Frederick Collins, U. S. N., formerly on Commander T. O. Selfridge's staff on the Atrato, re-examined and completed the survey of the route recommended by Commander Selfridge in 1871 and 1873. The party under Lieutenant Collins ran a new line of survey from the Atrato to the Pacific, following the Napipi Valley to its junction with the Doguado River, thence to its head-waters, and thence, crossing the divide at an elevation of 778 feet, to Chiri-Chiri Bay.

The direct distance is but 28 miles; the necessary curves increase this to 30.2 miles. Plans for a canal by this route will show a summit level of 143 feet above mean tide, a tunnel of 3.5 miles, and the use of 22 locks. Estimated cost, including twenty-five per cent. for contingencies, $100,000,000.

Lieutenant Collins reports, as a digest of the advantages and disadvantages of this route, in substance as follows: The character of much of the soil to be excavated is favorable for stable embankments and defense against loss by leakage or infiltrations; other advantages are the shortness of the artificial channel, excellence of harbors on each side, freedom of the location from terrestrial convulsion, abundance of material for construction, comparative facility for obtaining labor, and friendly disposition of the government and of the natives. The heaviest work would be on the Pacific side, which is more healthy and offers facilities for transportation.

The disadvantages lie chiefly in the necessity of a tunnel (its expense of construction and want of adaptability for commerce), the steep descent toward the Pacific requiring (like the almost unused Caledonia Canal) the grouping of a number of locks, limited water-supply during the dry season, dangers to constructions during the floods, shortness of season available for work, and undeveloped state of the country.

The expedition under Commander E. P. Lull, United States Navy, had for its objects the exploration of a route across the Isthmus of Panama, and to make likewise such examination of what has been known as the Chepo or Ba-

yanos route as would test the practicability of a ship-canal line from the mouth of that river to the capacious harbor of San Blas on the Pacific. This last was proved to be "hopelessly impracticable."

Across the Isthmus of Panama a feasible line was located. Total length, 41.7 miles; summit level, 129 feet; locks required, 12 on each side, and a tide lock at Panama; supply of water ample, to be obtained by a feeder from the River Chagres; estimated cost, $80,000,000. In connection, however, with any estimate for a line across this part of the isthmus, it must be remembered that it will be located within the section to which, under the renewed contract with the government of New Granada, the Panama Railroad Company has an exclusive right for canal or railroad.

All the explorations and surveys made on the American isthmus by our government during the last five years, viz., by Commodore Shufeldt across Tehuantepec; by Commander Lull across Nicaragua, Panama, and in Darien; and by Commander Selfridge and Lieutenant Collins on the Atrato route, have been referred by the President to a commission of engineers for examination and report upon their respective merits. This commission, composed of Major-General A. A. Humphreys, chief of Engineers; Commodore Daniel Ammen, chief of the Bureau of Navigation; and Captain C. P. Patterson, superintendent of the Coast Survey, will probably report on the whole subject at the coming session of Congress.* Mr. A. G. Menocal, C. E., who was Commander Lull's engineer on both of his expeditions, is now prosecuting inquiries at Greytown for the Nicaraguan government in reference to the work.† It is of interest, in connection with this subject, to notice that, after so many expeditions up and down the isthmus, the route now most favorably regarded should be between the two points of the isthmian region with which engineers have been quite familiar for the past twenty-five years. The interest of the local governments in the successful issue of the ship-canal project is manifested in the send-

* This commission has, since the above was written, reported in favor of the Nicaragua route.—*Ed.*

† For valuable information on this subject we are indebted to Professor J. E. Nourse, of the United States Naval Observatory, Washington, D. C., than whom the interoceanic canal enterprise has no abler advocate.—*Ed.*

ing by the Nicaraguan authorities of an official letter on the subject of interoceanic communication to M. de Lesseps, of Suez fame; who, in reply, favors the Nicaragua route as the best, provided it should be found impracticable to build a canal across the Darien isthmus, and proffers his co-operation in the event of the practical undertaking of the work. Finally, perhaps the most inspiring incentive to our government for the accomplishment of some one of the numerous canals projected across the American isthmus will be found in an examination of the last published report of the Suez Canal Company, which brings forward the statistics of this enterprise to the beginning of April of the year just closed. We append a summary of the more important items of this report:

The Suez Canal was opened to international commerce in the month of December, 1869, since which time, up to April 1, 1875, 5236 vessels made the transit, 2863 passing through from the Mediterranean, and 2373 from the Red Sea. Of the grand total, 238 were sailing craft and the remainder steam-vessels. The following figures, by years, will best illustrate the progressive increase in traffic:

Year.	Vessels.
1870	498
1871	763
1872	1082
1873	1173
1874	1264
First quarter of 1875	455
Estimated traffic for the past year	1820

The canal has become one of the main arteries through which the world's, and especially Great Britain's, traffic moves. The trade of Europe with the East has been virtually revolutionized within five years, inasmuch as the overland carrying trade has almost ceased to exist; the general trade of the East being to a great extent carried by the canal. The gist of the report, however, may be condensed in the statement that the great undertaking has commenced to "pay." In 1870, the net tonnage amounted to 436,609, yielding to the company 5,048,944 francs; in 1874 it had reached 1,631,640, yielding 24,748,900 francs. The company's annual expenses amount to less than 5,000,000 francs,

from which it may be reasonably inferred that, at the rate of increase which has hitherto taken place, the Suez Canal will in a few years more have achieved, from a commercial point of view, a most brilliant success.

At the last session of Congress an appropriation of $300,000 was made for the improvement of the Great Kanawha River from the Great Falls to its mouth, a work which, when realized, will complete a very important link of what is known as the "Central Water-line," connecting the James River at Richmond with the Ohio River at the mouth of the Kanawha. The distance from the Great Falls of the Kanawha to its mouth is 94½ miles, and the cost of improvement has been estimated at $3,000,000, which Congress will doubtless be called upon to appropriate in annual installments. In order that the money already appropriated should be used to the best advantage, the Secretary of War appointed a Board of Engineers with instructions to give the matter careful examination. This body, after a thorough investigation on the ground, decided to recommend the construction of stone locks, and to expend the $300,000 in building the first on the flats below Charlestown, Western Virginia. This lock is to be 300 feet long and 50 feet wide.

From abroad we may record that the Italian government has been engaged in the consideration of plans for the improvement of the Roman Campagna, a work which is warmly championed by General Garibaldi. A number of plans to effect the drainage of the numerous marshes, and the prevention of the frequent inundations of the Tiber, have been proposed, but thus far no definite plan of operation has been adopted. The experiment of introducing the malaria tree (*Eucalyptus globulus*) on a large scale is likewise said to be seriously contemplated, although the experiments already made in Italy have not proved satisfactory. The plan advocated by Garibaldi contemplated among other objects the construction of a canal from Rome to Ostia. This canal is to be available for navigation and irrigation purposes. The cost of construction is estimated at $6,000,000.

The problem of opening the interior of Africa to commerce has been earnestly advocated in certain quarters during the past year. Our last year's *Record* contained a brief allusion

to a proposition of this nature which was receiving some attention at the hands of the French engineers in Algeria. A plan, in its general features analogous to this last, was lately brought out and urged by Mr. Donald Mackenzie. The following is a brief synopsis of the arguments urged in its behalf: The Sahara is one of the greatest barriers to intercourse with the interior of the African continent; but, it is urged, a greater portion of this vast area, which was until a comparatively recent period the bed of an inland sea, may without very great difficulty be again restored to that condition, and be the means of distributing over the little known and to some extent wholly unexplored interior the produce and civilization of Europe and America. In the interest of this project several meetings have lately been held in London, at which Mr. Mackenzie presented his plans. "Although Africa," he said, "has an area of nearly a quarter of the entire land of the globe, it presents greater obstacles to human enterprise than any other part of the earth's surface, and thus, with immense natural wealth above ground and below, it is a lost continent, banished, as it were, from intercourse with the civilized parts of the world." His plan is to open a direct commercial highway from a point opposite the Canary Islands to the northern bend of the Niger at Timbuctoo, a distance of 800 miles, by removing a belt of sand and admitting the waters of the Atlantic Ocean to a vast depression in the Great Desert, having an area of 126,000 square miles. Timbuctoo would thus become a seaport about 2000 miles from England, and North Central Africa would be brought within reach of the harbors of Europe. However extravagant the foregoing proposition may appear, the alternative proposal to make a road, perhaps ultimately a railroad, along the depression of that ancient sea-bottom which extends from Cape Juby to the negro metropolis, seems to be a feasible and useful project. The promontory named faces the Canaries, and is consequently close to the southern provinces of Barbary. A diagonal line drawn thence to Timbuctoo, 900 miles distant, crosses the western portion of the Sahara, but the route leads through a comparatively low country, with convenient resting-stations and watering-places. From Timbuctoo the Niger is navigable for over a thousand miles. At present there is a caravan trade between Timbuctoo and Morocco

and the other Barbary States of not less than $15,000,000 annually, by a route much longer, the dangers and difficulties of which greatly increase the cost of goods at Timbuctoo. It seems reasonable, therefore, as the advocates of this project claim, that, were trade directed into the safer, easier, and shorter channel proposed, the existing one would be necessarily closed, while the station at Cape Juby, being in direct communication by sea with Northern Europe, would soon engross the commerce of South Barbary, which is said to be one of the richest, healthiest, and most fertile countries in the world, possessing a population of over three millions, whose only present means of intercourse with Europeans is by a most difficult road across the ranges of the Atlas, the cost of transportation across which often exceeds seven times the value of the merchandise. If any of the speculative projects for opening Central Africa to European commerce are ever to be carried into effect, the undertaking will probably be initiated by first putting some such proposal as that last described into operation, which can be done at comparatively little cost.

Upon the East River Bridge work has been slowly progressing during the past year. The latest accounts report that the Brooklyn anchorage is completed, and waiting for the cables and for the completion of the New York tower. Another East River bridge project has been authorized by the Legislature of New York, and certain steps preparatory to its erection have already been taken. The new company proposes to bridge the East River from New York to the Long Island shore at the lower end of Blackwell's Island. At this point the river is comparatively narrow, and a pier can be placed on the island. The surveys and soundings for its location have lately been completed by Mr. G. E. Harding. The total length of the proposed structure will be, including approaches, about two miles. It is proposed by the company to erect the long span trusses upon the cantilever principle. It is furthermore proposed to lay railroad tracks across it, and to make connection with the New York Central and Hudson River tracks through a tunnel under Seventy-seventh Street, on one side, and with the Long Island, the Southern, and the Flushing and North Shore Roads, at its termination at Graham Avenue and Lockwood Street, on the

other side. A new iron bridge over the Genesee Falls was completed last year for the Erie Railroad, and opened for traffic. A new suspension bridge over the Monongahela River, at Pittsburgh, was likewise contracted for. It is proposed to employ in its construction immense iron chains instead of the usual wire cables. An iron bridge across the Missouri River, at Atchison, Kansas, was completed on the 4th of August, and opened for traffic during the same month.

Work upon the new Bergen Tunnel of the Delaware, Lackawanna, and Western Railroad is progressing rapidly. Excavation was originally carried on from six shafts, which, together with the two outside ends, gave fourteen faces to work upon. The excavation is now about completed on four of the sections, so that there are but six faces at which work is being carried forward. Between shafts 3 and 4 there remains, at the time we write, 305 feet of heading to be done; between 4 and 5, 228 feet; and between 5 and 6, 109 feet; and in all about 1450 feet of bottom or bench work still to be removed. The total length of the tunnel, from face to face of the portals, will be 4270 feet. About 600 men are kept at work on the tunnel, the estimated cost of which will be $800,000. The work was begun in September, 1873, and, it is thought, will be completed by July, 1876.

A railroad tunnel under Newark Bay was likewise proposed during the past year. The approach to Jersey City from Newark across the marshes and the waters of Newark Bay (*via* the New Jersey Central Railroad) is effected by an elevated railway carried upon wooden piles. The unsafe condition of this structure during the winter and spring, and the yearly expense involved in keeping it in repairs—which has practically amounted to its rebuilding three times since its first completion—has led the company to seriously consider the practicability of building a tunnel under the waters of the bay from Elizabethport to Bergen Point. Prominent engineers consider the scheme a feasible one. A rough estimate places the cost of a tunnel for double tracks, extending a distance of 2½ miles, at $6,000,000, and which, if built, would last for a century.

The Channel Tunnel project, which contemplates the union of England and France by a submarine railway tun-

nel under the waters of the English Channel, has by no means been abandoned, as the following synopsis of the events of the past year in relation thereto will indicate. In April last the appointment of a joint commission by the English and French governments was announced. The duties of this body, which comprises eminent engineers of both countries, are to examine and report on the scheme of construction, so far as the same may affect the interests of either government. It is understood, furthermore, that the legislative concessions required for its construction have been granted by the two governments.

Latest reports state that soundings in the Channel are actively going on, and that the engineers in charge of the work are well satisfied with the results obtained. From Paris it is reported that preliminary operations prior to the commencement of the great undertaking have been begun. The members of the French Commission declare that an underground communication between France and England is only a question of expense; and the report they have drawn up and submitted to the French government, with the result of the soundings and of the study of the geological questions involved, is said to favor the belief that the project can be carried out with less expense than was at first imagined; and, finally, that the danger from leakage and infiltration will not be so great as was originally supposed. A shaft will shortly be sunk on the French side of the Channel, near Calais, to the depth of 350 feet, similar to that sunk some time ago on the English side, for the purpose of positively establishing the nature of the rock formation.

The details of the present situation of the project may be summarized as follows: In 1872 the Tunnel Company was organized, and Sir John Hawkshaw, Mr. James Brunlees, and M. Thomé de Gamond were appointed the engineers of the undertaking. On the English coast, St. Margaret's Bay, a depression in the chalk cliffs about four miles east from Dover, has been selected as the point of departure; and on the French side a spot about midway between Calais and the village of Sangatte has been fixed upon. By adopting this line, it is claimed from the observations of Sir John Hawkshaw, the tunnel can be almost wholly excavated in

the lower bed of homogeneous chalk, this stratum being 500 feet deep on each shore from high-water mark. In establishing the basis for this opinion, an examination was made across the Channel by dropping, from a steamer, a weighted instrument in 500 places, the apparatus running with great velocity to the bottom, and bringing up chalk where it was expected. The current is so strong along the proposed line that the bottom is washed quite clean, as the experiments conducted showed the absence of any deposit. From the examinations made there is every reason to believe that the chalk is continuous, and that it stretches beneath the sea uninterruptedly across the Channel. The maximum depth of water on the line of the proposed tunnel nowhere exceeds 180 feet below high-water mark, being deepest in the centre, and gradually diminishing in depth toward the sides. The tunnel itself would be placed by the engineers at such a depth that the thickness of the rock-bed over it would be nowhere less than 200 feet; and this depth, which is ample for security, would permit the railway approaches to be formed with tolerably easy gradients. The danger to be apprehended from the possible existence of fissures in the chalk, and consequent infiltration, is answered by referring to the experience had during the construction of the Brighton Tunnel, through the comparatively incompact upper chalk, for a distance of five and a quarter miles along the sea-shore, and from twelve to twenty feet below high-water mark, in close proximity to the margin of the sea. In this instance, although considerable water, mainly fresh, was met with, the work of construction was not notably obstructed in consequence. The engineers, finally, are unanimously of the opinion that the problem of ventilating the tunnel is easy of solution.

The future disposition of this magnificent scheme will probably be that the preliminary work (involving perhaps the cutting of galleries from both sides some distance under the sea) will be continued by private enterprise, until the feasibility of the undertaking is either disproved or established beyond cavil. Should this last prove to be the case, as seems quite probable, the two governments interested will doubtless be asked to come to the aid of the enterprise by the grant of a liberal subsidy.

The work upon the Severn Tunnel, to which we referred in our last year's *Record*, has been fully undertaken by the Great Western Railroad Company. The tunnel will be about four and a half miles in length, one half of which will be under the River Severn. When completed it will connect, in the most direct manner, the mineral and populous districts of South Wales with Bristol and the South of England, and will doubtless form the express route from London to South Wales. The work of excavation was started in December, 1874, and at last accounts was progressing at the rate of fourteen to eighteen yards per week. During the past year, likewise, several schemes for tunneling the Mersey between Liverpool and Seacombe were proposed.

Upon the St. Gothard Tunnel considerable progress has been made during the interval between our last annual report and the time of this writing. The following is the official report of the condition of the works on the 24th of September, 1875. The tunnel has been bored on the side of Switzerland 2500 meters, and on the side of Italy 2000 meters. As the work, when completed, will be about 15,000 meters, or, more accurately, 14,920 meters, in length, there remains about 10,500 meters yet to be bored. The altitude of the northern entrance at Goeschenen will be 3608 feet above sea-level, and that of the southern entrance at Airolo 3756 feet. The highest point in the interior of the tunnel will be 3780 feet above the sea, and will be reached from the Goeschenen end by a rising gradient of seven to 1000; from the summit there will be a falling gradient of one to 1000 to Airolo. The approaches of the tunnel have not yet been begun. The tunneling is performed by compressed air-machines actuated by water-power, and the explosive employed is dynamite. The daily rate of progress, according to latest advices, averages a trifle over seven meters. It is anticipated that the year 1880 will witness the completion of the tunnel.

We may record likewise the formation of an international company to effect the tunneling of the Simplon Pass; also of a company under the title of the "Intercontinental Railway Company," the main object of which is said to be to effect the union of Europe and Africa by a tunnel under the Strait of Gibraltar. As projected, it will extend in a right

line between Tarifa and Algesiras on the Spanish coast to Ceuta and Tangier on the Morocco shore. The submarine portion will be 44,160 feet, or nearly nine miles. This enterprise, thus far a mere proposition, will present far greater difficulties to its completion than the similar project for tunneling the English Channel, although the latter, as projected, will have more than twice the length of the former, inasmuch as the maximum depth of the Channel at the point to be traversed does not exceed 180 feet, while that of the Strait is 2621 feet. A tunnel beneath the Strait would therefore require to be bored at a much greater depth beneath the bed-rock—say about 1000 feet—which in turn would demand entry and exit galleries each about three miles in length.

The following miscellaneous items have a general interest in this department: The construction of a canal from Lake Michigan to the Mississippi River has of late been strongly advocated, as a means of lessening the cost of conveying the produce of the Upper Mississippi Valley to the sea-boards.—The sum of 8000 florins has been voted by the States-General of Holland for re-examining the project of draining the Zuyder-Zee, and for soundings to determine the quality of the soil at its bottom.—A subterranean pneumatic postal service is proposed between Paris and Versailles, in order to facilitate communication between the seat of the government at the latter, and the general service of the various departments at the former place. The line proposed is a double one, permitting the carriage of twenty kilos of dispatches an hour in both directions.—The Mexican Congress has lately granted an important concession, providing for the construction of a railroad of the standard gauge (four feet eight and a half inches) from the city of Leon, in the state of Jalisco, to the Rio Bravo del Norte, there to connect with the International Railway of Texas.—The opening of the Constantinople Underground Railway from Galata to Pera is worthy of mention. This unique work, which was thrown open for traffic in January last, is 672 yards long, and conveys passengers from the level of the Bosporus to the extreme height of Pera, an elevation of 200 feet, with an average gradient of one in ten. Its greatest depth below the surface is eighty feet, and the motive-

power is a stationary engine working a drum with endless bands. Trains are carried up and down simultaneously every five minutes, and their carrying capacity is placed at 30,000 passengers per day.—After many delays, the cable of the United States Direct Submarine Telegraph Company was completed during the past year, and is now in practical operation. The line, it may be remarked, is laid between Ireland and Nova Scotia, and another submarine section from Nova Scotia to Rye Beach, New Hampshire. This is the fifth cable now in use in the Atlantic service.—The subject of the adoption of the underground telegraph system within the limits of cities gave rise to considerable discussion.—A recent diplomatic conference on the metrical system arranged for the organization of an International Bureau of Weights and Measures at Paris.—During the past year the metrical system has been introduced into Egypt.

The preparations for the great International Exhibition at Philadelphia are, at the time we write, in a very forward state. The rapidity with which the erection of the Exhibition buildings has progressed during the past year, and up to the time of our writing, has been most satisfactory; and it may be regarded as settled that they will all be completed and ready for their appointed uses before the time announced by the Centennial Commission for the reception of goods. When this condition of forwardness is contrasted with the confusion which ruled at the opening of the late Exposition at Vienna, on account of the backward state of the work of preparation—and which was the cause of much complaint and unfavorable comment at the time—the energy with which the work at Philadelphia has been prosecuted is a cause for sincere congratulation. The intense earnestness with which the Commissioners entered upon their labors, and the quiet but thorough manner in which they have effected the work of organization, finance, and construction have completely disarmed the hostile criticism of some, and aroused from their apathy and indifference toward the enterprise another large body of our citizens residing without the limits of Pennsylvania; so that now, as the time draws near for the opening, a very general interest in the success of the Exhibition is manifested throughout the country.

The number of applications for space by intending American exhibitors is very large, and the indications concerning the active participation of foreign nations are such as to warrant the belief that the success of the Exhibition is assured beyond peradventure. No fears are entertained that the entire amount of space available for various exhibits, enormous as it is, will not be fully occupied. The preparations being made by the various railroad companies centring in Philadelphia for the transportation of goods and passengers are of a very complete character, involving the erection upon the grounds of several commodious dépôts. The passenger dépôt of the Pennsylvania Railroad Company will be 650 by 100 feet, opposite to which will be a large hotel. The tracks will be in a new yard adjoining the Exhibition grounds, and will be laid in a circle 1000 feet in diameter, flattened on one side. Trains will discharge and proceed around the circle to the rear of the dépôt, where some fourteen large sidings will be arranged. There will be over seven miles of tracks in this yard, which will connect with the freight tracks through the Centennial Buildings; and the facilities for the transportation of passengers are very complete. A large dépôt for the Reading Company is likewise in course of erection near the Memorial Hall, while a number of other companies have effected, or design to effect, arrangements for the same purpose. On the score of steam railway facilities to and from the grounds, there will be little room for complaint; while the large number of city passenger railways, for which Philadelphia has been noted, have made or are making extensive arrangements for the accommodation of the enormous local traffic that will be thrown upon them.

In addition to the five Exhibition buildings proper, viz.:

Main building...........................	covering	21.47	acres
Art Gallery (Memorial Hall)............	"	1.5	"
Machinery Hall.........................	"	14.	"
Horticultural Hall.....................	"	1.5	"
Agricultural Hall......................	"	10.15	"

there will be a government building devoted to an exhibit of the operation of the several national Executive Departments, and of the Smithsonian Institution; a Women's Pavilion, for the exclusive exhibition of articles of women's

handiwork, and a number of smaller structures for the administration of the Exhibition; in addition to which numerous applications have been made by manufacturers and by the Commissioners of foreign governments for permission to erect pavilions and numerous ornamental and useful structures within the Exhibition grounds, which applications in many cases have been granted.

The general reception of articles at the Exhibition buildings commenced January 5th, 1876, and will close on the 19th of April following; and every available means for the diffusion of information to intending exhibitors concerning the shipment of goods have been employed by the Bureau having this work in charge.

The Exhibition will be opened on the 10th of May, 1876, and closed on the 10th of November following. The removal of goods will not be permitted until the close of the Exhibition.

For detailed information concerning the Exhibition, we refer our readers to the official documents issued by the United States Centennial Commission in Philadelphia.

In close connection with the foregoing subject, we may mention that a plan has been organized for the establishment of an Industrial Museum—on the plan of the South Kensington Museum in London—to occupy Memorial Hall after the Exhibition. The institution will be known as "The Pennsylvania Museum and School of Industrial Art," and proposes to embody a museum of art in all its branches as applied to industry and technology, giving instruction in drawing, painting, wood-cutting, and designing for industrial purposes, through lectures, practical schools, and special libraries.

Technology.—The problem of mechanical puddling attracted more attention during the past year than ever before, although the results obtained in the different manufacturing districts into which rotary puddlers have been most largely introduced are somewhat conflicting, from which it would appear that the problem of puddling by machinery has not yet been wholly solved. In certain quarters of England, and in Pittsburgh in this country, the Danks furnace has given great satisfaction, and the number of furnaces has been increased. In certain other districts the experience

with this system has not been so fortunate, while the Crampton system has been very successfully operated.

In England, where comparatively greater activity in the manufacture of iron during the past year prevailed than in this country, the Crampton system, in this special field, appears to have been steadily gaining in favor. In our brief allusion to the Crampton plan in last year's *Record*, we noticed that its chief features resided in the adoption of a water-jacket arrangement and the use of dust fuel; and it is very suggestive to note that in certain modified Danks furnaces lately erected in England, the leading improvement consisted likewise in the introduction of a water-jacket arrangement—approximating therefore in construction to the Crampton furnace at least in the mode of cooling by water. So far as relates to the speed of working, both systems appear to be equally good, provided the apparatus is in good condition; but in the quality of endurance under the rough usage of practice, which in this case happens to be the test of commercial success, the friends of the Crampton system lay claim to decided superiority. With regard to the relative merits of the latter system and the modified Danks furnaces just referred to, a competent authority speaks as follows: "As to what would be the relative endurance of two furnaces, each constructed on Mr. Crampton's plan with water-jacket arrangements, but one worked on the Danks system and the other with dust fuel, there are no data for actually determining; but there are certainly no reasons for believing that the results would be in favor of the former." And the same authority sums up a comparative *résumé* of the subject in these words: "Altogether, when we consider the numerous advantages attendant on the use of fuel in the form of dust, and the general excellence of the mechanical arrangements which [illegible] npton has designed and practically carried into ef- [illegible] he utilization of such fuel, we can not but regard [illegible] pton furnace as the most advanced solution of the [illegible] of mechanical puddling." On all hands, finally, it [illegible] ed that the ultimate success of mechanical pud- [illegible] assured, and that the puddling process of the fut- [illegible] be carried on in rotary furnaces capable of deal- [illegible] large charges, and worked in connection with

plant capable of easily manipulating the large puddled balls produced.

A very useful sketch of the various methods for producing phosphorus steel (or, to use a more correct definition, phosphorus cast metal), to which we alluded in last year's *Record* in a description of the results obtained by M. Euverte at the Terre Noire Works, has been published by M. Gautier, from which it appears that considerable success has been attained. M. Gautier agrees in the general statement that phosphorus may be allowed to remain in steel without exercising any practically injurious effect upon its qualities. This metal, he remarks, can not be employed in industry except on condition that it is nearly deprived of carbon; consequently every process that yields extra-soft steel will, with inferior materials, produce phosphorus cast metal.

With regard to the future development of the Bessemer process, it may be of interest to record the following views of the same metallurgist. The Bessemer process, he affirms, is destined to lose much of its importance in presence of the certain and unlimited extension of the Siemens-Martin process, which he considers will take the lead in future, and regulate prices. It is capable of using up old iron and employing all kinds of ore, for puddling is still the only known method of practically getting rid of the sulphur and phosphorus contained in irons; while the Bessemer process, requiring as it does special grades of iron, will always have a limited application.

Perhaps the most reliable estimate of the relative merits of the Bessemer and the Siemens-Martin processes will be found in the following considerations, which embody the opinions of eminent judges: There are at least two defects in the application of the Bessemer process, or perhaps it would be better to say, two obstacles to be encountered in the practical working of the method that seem difficult to overcome. One is the impossibility of using directly pig-irons containing sulphur and phosphorus in any appreciable quantities, and the other the difficulty of controlling the quality of the product. These obstacles are too well known to need enlargement. Though the first obstacle will not in the future be so serious in America as in England, owing to the existence of large deposits of ore in various

localities suitable for the manufacture of Bessemer pig, and which will doubtless be rapidly developed under the stimulus of an increasing demand; nevertheless the cost of making pig suitable for this process is so much greater than the cost of ordinary pig as to be a large item in a ton of rails. The difficulty of controlling the amount of carbon is also well known, and is a serious item in the cost. In every cast made, the amount of carbon must be determined, sometimes by chemical analysis, and again by tests of a mechanical nature.

The Siemens-Martin method has the advantage of the Bessemer in these particulars: Irons containing a much higher percentage of sulphur and phosphorus can be used, it being estimated that about two thirds of the sulphur and three fourths of the phosphorus are eliminated in the process. The crop-ends of bars, scraps, all descriptions of waste, and old wrought iron can also be utilized—in a word, grades of pig-iron that could not be used in the Bessemer process, and much that would be waste, can be readily used. In the Siemens-Martin process the quality of the product is completely under control. Should the metal at the time of testing be too soft, more pig can be added; while, if too hard, simply waiting a few minutes will correct it. The loss in the open-hearth process is considerably less than in the converter—according to Gruner, about one half.

The decided advantage of the Bessemer process is the great amount of steel produced per day, and the cheaper cost of production. In some instances the amount has, with a pair of 5-ton converters, exceeded 200 tons; while 10 tons would be a good day's work with an ordinary open-hearth furnace. With the Pernot modification of the Siemens-Martin furnace there is a prospect that this objection may be overcome. It is claimed that with Pernot's furnace 40 tons per day of Siemens-Martin steel can be produced, and we have the authority of an eye-witness for saying that the claim is well-founded. If this is true, then with six of these furnaces a product fully equal to that of a pair of 5-ton Bessemer converters could be obtained. The cost of the plant would not be more than half that of a Bessemer, the quality of the product can be controlled with ease, pig-iron inferior to that required in Bessemer could be utilized, all scraps could be

worked over, and the cost of steel equal in grade to Bessemer would not exceed the latter.

In Bessemer practice the experimental trial of the hot blast is worthy of notice. The *Berg- und Hüttenmännisches Jahrbuch*, in which the record of the trial is made, states that at the Bessemer Works at Zeltweg, Germany, some fifty or more charges run with a blast heated to nearly 1300° Fahr. The result of these trials demonstrated, what had before been surmised, that a slightly carbonaceous iron could be used in the Bessemer process with hot blast. It was likewise found that more rail-ends could be thrown in than ordinarily. Iron that with cold blast could stand only twelve per cent. of rail-ends took up with hot blast eighteen per cent. It was, however, found to be impossible to conduct the operation continuously, because of certain practical difficulties that were met with. The chief of these was the rapid wearing of the bottoms of the converters—while one would ordinarily stand about fifteen charges, it was found in these trials to be useless often after only two charges. Another difficulty was found to be the excessive heating of the parts of the apparatus in contact with the hot air. These practical troubles, it is said, caused the abandonment of the experiment, though the results obtained were sufficiently favorable to warrant the statement that the employment of the hot blast in Bessemer practice is attended with advantage, though the manipulations demand experience and practice.

During the past year the results obtained by Sir Joseph Whitworth and others in compressing steel in the liquid state by hydraulic pressure, in order to secure more perfect homogeneity of structure and increase in strength, have attracted considerable attention. In common practice, steel which is cast into ingots is more or less honey-combed by bubbles of gas distributed through the structure, which honey-combing it is endeavored to remove after solidification by the processes of cogging, hammering, and rolling the material while in a heated state. To avoid this honey-combing, some manufacturers have succeeded in producing thoroughly sound steel castings by "dead melting" the steel, employing moulds with a non-conducting lining and running the ingots with a sufficient head. We are not aware that any comparative tests have been instituted with steel so cast and

fluid-compressed steel by the hydraulic method above alluded to.

The fluid compression of steel is generally admitted to have been first suggested by Mr. Bessemer, and has been very successfully in operation, with various modifications, in France and Austria for a number of years, and of late in England.

Another process for the direct production of iron from the ore was published during the past year. It is a modification of the Siemens process, the modification residing in the fact that the ore is first melted before reduction with carbonic oxide. The ore is first melted on the basin-shaped hearth of a Siemens furnace, where it is heated to the highest temperature attainable, and the reduction then effected by introducing carbonic oxide (or other reducing gases) at the working door through a hollow rabble which is moved about through the bath. By this process it is claimed that the precipitation of the iron is effected in a few minutes; and inasmuch as the gasification of carbon does not take place at the moment of reduction, it renders possible the production of a temperature sufficiently high to maintain the ore in the molten state while the reduction is taking place. The process is the invention of Director Kazetl, of the Neuberg Works, in Styria.

At the last session of Congress an appropriation was made, at the instance of the American Society of Civil Engineers, of a considerable sum, for the purpose of having a series of tests made of the strength and other qualities of American iron and steel. The commission appointed by the Secretary of War to conduct these experiments comprises the names of some of the most eminent mechanical engineers in the country. A classification of the work as the commission purposes to perform the duty assigned it has been issued; and manufacturers and others throughout the country who are interested have been invited to co-operate with the members by sending samples of their products for examination, and by imparting any information in their power. The report of the commission will doubtless possess a permanent value.

In direct connection with the above, we may likewise add that the Franklin Institute, at one of its recent meetings, ap-

pointed sub-committees on the strength of iron and steel, with instructions to make experimental trials with materials actually employed in the construction of boilers, bridges, and other structures of iron and steel.

As indicating the growing appreciation of the value of gas fuel in metallurgical and allied operations, and of the great economy resulting from its use, we would refer to the rapid increase of the introduction of the regenerative furnace of Siemens, which has of late been extended to various other industries besides iron and steel for heating purposes. The Secretary of the American Iron and Steel Association authorizes the statement that in this country there are in operation 32 crucible steel-melting furnaces, capable of producing 45,000 tons of cast steel per annum, and 14 open-hearth furnaces for the manufacture of steel by other processes, of a working capacity of 35,000 tons per annum.

Throughout the country, likewise, there are at various iron and steel works 56 of the Siemens gas-furnaces in operation, capable of heating at a single turn over 300,000 tons of iron and steel per year of 270 working days. In addition to the foregoing, there are also in successful operation a number of single and double puddling furnaces, glass furnaces, etc., and there are in present course of construction 44 furnaces, to include crucible steel-melting, open-hearth, heating and puddling furnaces. Nearly all of these have been erected within the past eighteen months.

In close relation to the above stands the use of natural gas, the largely increased introduction of which for industrial purposes throughout the neighborhood where it is found attracted great interest during the last year. The flow of natural gas from oil-wells and gas-wells has been utilized for heating and lighting purposes in several localities in Pennsylvania for some years. The credit of having first applied natural gas to metallurgical purposes belongs, so far as we are informed, to Messrs. Rogers and Burchfield, iron manufacturers, at Leechburg, Pennsylvania, who have successfully applied natural gas for about two years to all the operations incident to rolling-mill practice. The results obtained by these enterprising manufacturers were so satisfactory that wells were sunk for gas at various other localities where it was supposed to be attainable, and the flow

utilized for metallurgical purposes. Wells for this purpose have lately been sunk at and near Pittsburgh, on the Ohio River at various points, and at Newcastle, in the Chenango Valley. At the latter place, a well put down by Brown & Berger is reported to have reached a good supply at a depth of 2500 feet. At Beaver Falls, Pennsylvania, a well formerly sunk for salt water was deepened several hundred feet, and at the depth of 1100 feet a strong flow was obtained, which it is proposed to introduce at once into the iron and steel works there; it has already been utilized by the file-works at Beaver Falls for heating purposes, and it is said with very economical results as to cost compared with coal, while it is far superior for use in tempering. Quite recently a company, comprising a number of prominent iron manufacturers of Pittsburgh, purchased the "great gas-well" in Butler County, Pennsylvania, with the avowed purpose of bringing the gas for use as fuel to their iron-works, a distance of about 17 miles. It is very gratifying to add that the experiment promises the best results. Pittsburgh papers, just to hand, convey the information that the laying of the pipe has been completed, and the practicability of transporting the gas for that distance (17 miles) in sufficient quantity to be of utility in extensive industrial operations, fully demonstrated. Twenty minutes after the gas was turned on at the well it was rushing through the terminus of the pipe at Ætna, and in volume sufficient to supply double the quantity of heat required at each of the iron-mills in that vicinity. The gas is conveyed through a six-inch pipe, tapped where needed with tubes of smaller calibre, and will be introduced without delay into the furnaces of numerous iron-mills. It is furthermore reported that a project is being mooted to purchase all the gas-wells in Butler County, and bring their product to the Pittsburgh manufactories. As the feasibility of the scheme has already been demonstrated, we may look for decided changes in the methods of iron-making in and about Pittsburgh and the region lying in the course of the suspected northern and southern extension of the gas-producing belt.

Other innovations in the direction of greater economy in the use of fuel for industrial operations have been introduced during the year just passed. In June last a new ma-

chine, invented by Dr. J. R. Hayes, for pressing coal-dust into fuel, was put in operation at the Harrisburg machine-shops. The apparatus employed is said to be capable of producing a ton of compressed coal in six minutes. The mechanism is described as being simple, and the operation of utilizing the coal-waste quite inexpensive. Concerning the projected works of the "Loiseau Pressed Fuel Company," to which reference was made in our last volume, nothing further has transpired during the year.

As an important item in connection with the employment of gas fuel in metallurgy, we must allude to the system of furnace-working with petroleum, which appears of late to have made substantial progress. Considerable attention was drawn to this subject during the last year by the publication of a careful investigation of the system of Dr. C. J. Eames, in practical operation at an iron-working establishment in Jersey City. The investigation was conducted by Professor Henry Wurtz, whose opinions on this subject are worthy of the greatest respect; and the conclusions which he announces bear most favorable testimony to the value of this particular process, and to the system in general, both with respect to economy of operation and quality of product. Without entering too much into details of construction, it may suffice to remark generally that in the Eames system the oil is introduced into the furnace, in any desired volume, in the form of a vapor, evolved in a so-called "Vapor-Generator," so constructed that no possible interruption can occur in its action, and that the device for securing rapid, complete, and uniformly distributed combustion of the vapor with the enormous volume of air that is required is effected by an adjustment of great simplicity and efficiency. The generator—which is the essential feature of the new process—is a cast-iron vessel, with horizontal shelves projecting alternately from opposite sides, over which shelves the oil flows downward in a thin layer, dripping from shelf to shelf. In this condition it is met by a slow opposing current of steam heated to incandescence, and kept at a pressure of about ten pounds per square inch, which passes upward into the chamber from a superheating coil placed below it, and heated by a fire. Every trace of oil is taken up in vapor, and swept onto a mixing chamber, which occupies the fireplace of the

ordinary system, where it meets the air-blast. The former bridge-wall of the furnace is built up solid to the crown, except a narrow space called the combustion-chamber, which is an important feature of the device. This consists simply of a cellular tier of fire-bricks, placed on end, extending all across over the old bridge-wall. Within these cells the combustion commences, and the course of the flame is directed as may be required.

With this apparatus—the essential features of which are dwelt upon in what has preceded—Professor Wurtz affirms that the economical advantages in siderurgy, of added intensity of temperature and energy of concentration of heat, in saving of time as an element of work done, are even greater than have been contemplated by those who have fully admitted these facts on general principles; so much greater that in siderurgical practice, where the heat taken up by the iron is but a small fraction of the total heat, the calorific superiority of oil over coal, weight for weight, actively and effectively rises to the ratio of *eight* to *one*. The quality of the metal produced likewise left nothing to be desired. From the foregoing, it would appear that the system of furnace-working with petroleum has achieved a notable success.

In last year's *Record*, with reference to the progress made in the field of illumination, allusion was made to the growing popularity achieved by several processes employing petroleum in lieu of gas-coal in the manufacture of illuminating gas. It is of interest to record in this connection some reference to the "Lowe" process, the invention of Mr. T. S. C. Lowe, of Norristown, Pennsylvania, which has during the past year been introduced to light the city of Utica, New York, its practical efficiency and economy having been previously abundantly tested on the working scale at Conshohocken and Phœnixville, Pa., at which latter place it has been operated with great satisfaction for the past two years. The difficulties on the score of stratification and condensation, to which the petroleum water-gas processes as a class are supposed to be subject, appear in the case of the Lowe gas to have been, practically, entirely obviated, the product possessing a permanence and uniformity of quality, winter and summer, equal at least to coal gas. Mr. Lowe's process consists in producing from anthracite and the de-

composition of steam a gas of high heating power (which he employs as a heating gas fuel in metallurgical operations), and then enriching this by means of crude petroleum when the gas is to be used for illuminating purposes. In its mechanical details the process is claimed to present marked features of difference from others. In all other methods the system of retorts or equivalent vessels heated externally has been to a large extent followed. In this, however, it has been entirely abandoned, and the materials for decomposition are introduced directly into the fire itself, by which, it is claimed, there is secured the greatest possible economy of heat. This difference is affirmed to result in important advantages. The process is concisely as follows: The anthracite is charged in a small cupola of about 3 to 4 feet in diameter, the bed of coal being kept from 3 to 4 feet deep. When fairly ignited, the base is closed, and superheated steam is admitted through tuyeres a short distance above the grate-bars. The steam in contact with the glowing coals is decomposed, and water-gas (hydrogen and carbonic oxide) is formed. This it is designed to utilize as a heating gas. To render the gas fit for illuminating purposes, a jet of crude petroleum is directed onto the surface of the burning coal, and the mixed water-gas and petroleum vapor, generated in the same chamber, and simultaneously, are passed into the secondary chamber of fire-brick, where they are subjected to a still further increase of temperature, which treatment serves to render the product permanent. Thence it passes through the washing and condensing apparatus, onward through the lime-boxes to the holder. The charge which has been used in some of the works where this process has been introduced has averaged 280 gallons of crude petroleum and 3600 lbs. of anthracite for the production of 70,000 cubic feet of illuminating gas of a quality not less than 20 candles, and at an average cost of 56 to 60 cents per 1000 feet. At Utica, which is the largest place yet lighted by this system, it is expected to reduce the cost of manufacture—maintaining the same quality as above named —to 50 cents (or less) per 1000 feet. At these works, which have lately gone into operation, two men, at laborers' wages, make all the gas required by the city, the coal gas having been entirely superseded.

The performance of this and similar systems is deserving of far more attention from the public than it has yet received.

Experiments have lately been made in Berlin with the view of determining the adaptability of the electrical light for military signaling. The light employed—which was one of great intensity—was so arranged with an inclosed mirror that the rays were projected against the clouds, which, serving as a screen, repeated on a gigantic scale in the sky the signals made in front of the mirror.

It is likewise of interest to record in this connection that M. Gramme has communicated to the French Academy the fact that he has effected substantial improvements in the construction of his dynamo-electric machine, by the employment of the thin-plated magnets suggested some time since by M. Jamin. By their use he is enabled greatly to augment the intensity of the currents. The new machines have only one central ring instead of two, two electro-magnets in place of four, their weight and size are greatly diminished, and their capacities notably increased as compared with the earlier machines.

We recorded last year the invention by Messrs. Edison and Prescott of the ingenious quadruplex telegraphic instrument, by means of which two messages may be sent in the same direction and two others in the opposite direction simultaneously upon the same wire. A number of these instruments have been introduced during the past year, and with marked success. In this volume we may record the first public trial of a discovery in telegraphy which promises even more wonderful results, and by which it is affirmed, on good authority, that at least sixteen messages can be sent simultaneously over a single wire. The new system is the discovery of Mr. Elisha Gray, of Chicago, and is termed "the Electric-Harmonic Telegraph." The invention, which has been practically developed during the past year, is at present being tested upon the lines of the Western Union Telegraph Company.

Mr. Gray's system of multiple transmission is founded upon the principle that composite tones are as readily transmitted by a wire as single notes. The depression of each key sets a self-vibrating electrotome in operation, which is

adjusted or tuned to vibrate at a certain rate, differing from that of any of the others, when under the influence of the electro-magnet controlled by its corresponding key. These several sets of electrical vibrations are transmitted through the circuit without interfering with each other, in the same way that any number of different sets of sound waves may pass through the air without mingling or interfering. At the receiving station each instrument is so adjusted as to respond to its own special sets of waves, or vibrations, without regard to others. By breaking and closing the circuit upon the transmitting electrotome, so as to form telegraphic signals, these are transmitted and taken up by the corresponding receiving apparatus. Concerning the experimental trials which are being made with this remarkable apparatus, we learn that, while certain minor difficulties were shown to exist, which it is anticipated may readily be overcome by suitably modifying the transmitting apparatus, enough has been demonstrated to show that the invention is destined to become a very useful and important one. It may be remarked, incidentally, that one of the peculiarities of Mr. Gray's system lies in the fact that while sixteen persons may be using the wire, none of their messages need interfere with the others, or become known to any of the others save the sender and the designated receiver. On September 11th an experiment test of the apparatus was made on a wire between New York and Boston (240 miles in length), over which four separate messages were simultaneously transmitted from Boston, and copied from four sounders by a like number of receiving operators in New York. It must not be inferred that the number of communications that may be carried over the same wire simultaneously is limited to sixteen, since in theory the system knows no limit as to number, and in practice the extent to which the multiple transmission is carried will depend solely on the perfection of the mechanism. We await the future development of this invention with much interest.

A brief abstract of the facts relative to the industrial employment of paper may not be out of place, in view of the increasing importance of the subject.

It has long been known to chemists that certain substances will act powerfully upon cellulose (or vegetable

fibre), and a number of processes have been devised for utilizing these facts in the arts. The peculiar compound known as cupro-ammonium appears to be an admirable solvent for cellulose, dissolving it completely without in the least destroying its properties. From this solution the cellulose can be again precipitated in a perfectly pure state by the employment of the proper re-agents. This observation has already been utilized in the manufacture of a number of useful articles from woody fibre, paper stock, seaweed, and the like. It has been employed in making paper impermeable to water, the sheets being simply immersed for a few seconds in the metallic solution, then passed between rollers and dried. Paper thus treated becomes quite impermeable and leathery, resisting even the disintegrating action of boiling water. By passing a number of sheets together through the rollers, an extremely thick and tough fibre is produced, which forms an excellent substitute for leather, and for which doubtless a great variety of uses will be found. The cupro-ammonium treatment of paper has already been successfully applied to the production of roofing, gas and water pipes, hats, boats, clothing, etc.

Other processes for the treatment of paper have been devised, and of late to some extent utilized in the arts. The well-known paper-parchment, which has only of late years come to be properly valued, is prepared, as was discovered by Hoffman, by passing unsized paper through strong sulphuric acid. By this simple treatment it is converted into a substance closely resembling parchment in its appearance and behavior, being not only remarkably strong, but also quite impervious to water, hot and cold. A number of metallic salts, of which we may mention chloride of zinc and chloride of aluminum or tin, also act powerfully upon cellulose. Paper passed through a solution of either of these substances is affected in the same manner, and perhaps quite as decidedly, as when treated with cupro-ammonium; and of the article thus prepared quite a variety of applications has been made. When freshly prepared, this article can be pressed into moulds, and made to assume any desired form by this and other means. There have been made combs, knife, fork, and brush handles, gas and water conductors, and a great variety of articles of utility or ornament. Even

car-wheels have been made from it by strongly compressing a number of sheets together, and, if report has not exaggerated, their behavior in practical use is excellent.

Carton-pierre (paper-stone), another material prepared with paper, has of late attracted much attention. As may be inferred from its name, it is one of the many varieties of *papier-maché*, and is claimed to partake of the nature of stone in appearance and durability, possessing at the same time a fibrous quality and a certain elasticity, so that it might properly be described as a manufactured material taking an intermediate place between stone and wood. It is therefore as a substitute for these two materials that it has done most service, finding a natural and inviting field in all classes of architectural enrichments, where boldness and beauty make strength and lightness necessary to permanence and safety.

While the cost of its constituents prevents its competing with stone, slate, or wood in their plain or unshaped conditions, it can, however, be produced in any ornamental form very much cheaper than the same article could be manufactured from the articles named, the pattern or model of the article required being of course a prerequisite. In general, the material is composed of carbonate of lime and paper, combined with animal glue, to which, however, various other articles are added, such as flour, oil, rosin, siccatives, etc., depending upon the requirements of the thing to be produced. It is worthy of note that it has superseded plaster of Paris for architectural decorations in many of the large cities of Europe, and especially in Paris; the plain walls and lines being of plaster and the adornments in *carton-pierre.*

The fact that figures of great size and very considerable strength can be produced in complete relief and very light, has recommended its introduction very largely into public buildings. It is but a few years since it made its first appearance in this country as a manufacture, but native ingenuity had scarcely touched it before it showed signs of improvement, and new fields for its utilization were opened. It has been lately produced of a nature that will permit it to successfully resist heat almost equal to slate, and without that danger of splitting in strata that renders the use of ornamental slate objectionable; besides which the *carton-*

pierre possesses a toughness to which slate is a stranger. For this reason it has almost entirely monopolized the ornamental work of mantels; besides being extensively employed for columns, pedestals, bases, clocks, etc., marbleized in the same manner as slate and with as fine a finish.

As made by the American process, it paints better than wood; bronzes almost equal to metal; marbleizes with a finish equal to the natural stone; and, what is especially worthy of mention, it is said to gild better than any other known material employed in the arts, in consequence of which it has, within the short space of six years, completely supplanted every competitor in the field of ornamentation for mirror-frames and gilt-work wherever it has been brought into competition with them. Its future applications, in connection with *papier-maché*, are almost unlimited, and together they are quietly working quite a revolution in certain directions; a fact that will become more and more apparent as timber disappears, and increasing remoteness lends addition to its value.

In connection with the processes in vogue for the injection of timber with preservative solutions, we will allude to what appears to be a decided improvement on the Boucherie system—hitherto the best—and which was brought to public notice during the past year. In this process—the invention of G. B. Smith—a ring of steel having a knife edge is partly driven into the butt of the sawed log, upon which is fastened a cap of cast iron by rods and chains passed over the other end, the inner face of the cap being planed so as to afford a water-tight joint with the outer flat side of the inserted ring. The cap is in connection with a pump, by means of which the preservative solution (any that may be desired) is forced by hydraulic pressure through the natural sap channels of the wood, driving out the sap before it until it makes its appearance at the other end, when the log will be found to be most thoroughly injected, from centre to circumference, with the liquid employed. The superiority of this method of injection over the numerous processes involving the employment of closed vessels in combination with high temperatures and pressures, which can only effect at best a partial impregnation of the wood, and are necessarily attended with a greater or less amount of mechanical weakening and

rupture of the fibre, will be apparent, while its great simplicity and directness will commend it to general favor.

A French inventor, M. De la Bastie, has succeeded in producing, by a simple process, specimens of glass, perfectly clear and transparent, but extremely hard and durable. He calls the product *verre trempe*, or tempered glass. The liquid in which the glass is tempered is said to be a compound of melted wax and resin and various oils, the ingredients being mixed in different proportions according to the purpose for which the glass is intended. Into this liquid, heated to the desired temperature, the glass, which has reached the required heat in the oven, is pushed out upon a metallic slide, and descends by it upon an inclined plane placed in the vat. The depth to which it is allowed to sink in the oil is regulated by a species of brake, which stops at the proper point. It is allowed to remain in the bath for about a minute, when a self-acting rake draws it into a metal frame, which is removed from the vat, and the glass is allowed to cool. Meantime more glass has taken its place in the vat, the operation being thus made continuous. This tempering process is said to add decidedly to its value, and most extraordinary accounts of the resisting qualities of the *verre trempe* have reached us; on which account the process promises to become of great importance. In this connection it may be added that, while the idea of tempering glass is not a new one, attempts having repeatedly been made at glass-works to effect it, M. De la Bastie appears to have been the first who has succeeded in solving a number of practical difficulties, which appear to have rendered previous experiments of this kind but indifferently successful.

The investigations of Professor Kolbe, of Leipsic, brought into great prominence last year a new antiseptic agent—Salicylic acid—which has demonstrated itself to be of great value in medicine and in the arts. Salicylic acid behaves in nearly every respect like carbolic acid, for which it is recommended, and already largely adopted as a substitute. It appears to be equally powerful with the latter in arresting fermentation and putrefaction, in addition to which it possesses the advantages of being tasteless, odorless, and non-poisonous. As a substitute for carbolic acid in medicine and surgery, it has already achieved great popularity.

A number of *mechanical* novelties are worthy of mention. Of these, perhaps the most interesting is the application of the sand-blast for producing upon plated-ware or silver a lustreless, very finely grained surface (called by the trade a satin finish). The usual method of effecting this is by a number of swiftly revolving brushes, made of fine wire. The adaptation of the sand-blast for this purpose is said to be perfect. The operation is exceedingly rapid, as the article has only to be turned so that the blast strikes for an instant upon the required portions, the article being covered by a rubber screen of suitable pattern.—A self-feeding nail machine, making sixpenny nails at the rate of 300 to 360 per minute, has lately been put in operation at the nail factory of the Albany Iron-works.—Mr. M. Orum, of Philadelphia, has invented a very simple and perfect method of bending metal pipes, which consists in the employment of a closely coiled spiral of square steel wire, of a diameter suited to that of the pipe to be bent. This spiral is inserted into the pipe, and acts as a flexible mandrel. When the pressure is brought to bear on the pipe, this flexible mandrel affords it an equable though elastic support, and permits the bend to be accomplished in the most perfect manner, and in a fraction of the time required by the method commonly used.—The so-called "Brayton Motor," which attracted considerable attention during the year, is an ingeniously contrived engine, operated by the expansive force produced by the combustion of a mixture of petroleum vapor (or gas) and air. It differs in several essential features from other gas and vapor engines. To avoid the inconvenience and loss of time involved in fixing upon a lathe chuck, in the ordinary way, certain special kinds of work, such as thin steel disks or small circular saws, the ingenious artifice of converting the chuck into a temporary magnet has been resorted to with great success. Under these circumstances, the steel pieces when placed on the face of the chuck are held there firmly by the magnetic attraction, and when finished can readily be removed by breaking the galvanic circuit and demagnetizing the chuck. The same principle has been applied to machine tools for holding articles of large diameter and weight.—The National Tube Works Company, in addition to making wrought-iron pipe of unusually large size,

has introduced the novelty of an enameled water-pipe, which they now manufacture of all sizes from one eighth of an inch to sixteen inches in diameter. It is claimed for this iron coating that it has been subjected to the most severe chemical tests successfully; that it will protect the metal effectually from rust or corrosion by acids; and that it is indifferent to the action of heat and cold, boiling water, etc. For domestic water supply, it would appear to possess decided merits.—In addition to our allusion to the discovery of the great ore-body (or bonanza) on the Comstock lode, it is of interest to mention the opening of a mine yielding gold, silver, copper, and lead near the town of Newbury, Essex County, Massachusetts. Several shafts are down, meeting an abundance of ore, much of which is of high grade.

As the space at our command is limited, we may add, in conclusion, it has been necessary, in our general *résumé*, to curtail our remarks upon many important topics, to simply allude to others, and to omit all mention whatever of numerous items of general interest. To a large extent, however, this fault is remedied by the addition of the copious body of descriptive items, which will be found under suitable classifications in another place.

TECHNOLOGY.

In the field of *Chemical Technology* we may record that Kuhlmann has devised the following method of effecting the regeneration of the manganese residues in the manufacture of chlorine.

The crude chloride of manganese solution is mixed with chalk (in order to get rid of iron as a carbonate), and then with milk of lime, to convert the chloride of manganese into oxide. This oxide, after careful washing, is dissolved in nitric acid, the solution evaporated, and the dry residuum heated in retorts to a temperature sufficiently high to drive off the nitrogen as hyponitric acid and nitric oxide, but not so high as to decompose the binoxide that will have been formed. These vapors are led into and absorbed by the hydrated oxide of manganese obtained as above detailed; the salt resulting is calcined, and the terminal stage of the above-described operation gone through with it, and so forth. In this manner the process of regeneration can be

carried on for an indefinite period, with very little loss of nitric acid.

The presence of lime in the oxide of manganese increases the percentage of loss of hyponitric acid, to avoid which the inventor recommends the employment of just so much lime as will be necessary (the proportion by equivalents) to oxidize the chloride of manganese. By the use of this process Kuhlmann claims to be able to regenerate 88 per cent. of the superoxide of manganese. By the process of Weldon, which is much simpler (vide *Annual Record*, 1873, p. cxxx *et seq.*), some 70 per cent. is claimed.

Hargreave's improvements in the alkali manufacture are said to be making rapid progress, while the ammonia process is not found to work so well as was at first anticipated. Grüneberg & Vorster, of Cologne, have patented a process of obtaining caustic soda by passing superheated steam over a heated mixture of common salt and of alumina or its hydrate.

Dr. Crookes affirms that the application of Sprengel's device of employing atomized liquids in operations where a liquid is made to act as an absorbent of a gas has effected a material improvement in the production of sulphuric acid. In the ordinary process of manufacture, the sulphuric acid as contained in the chambers contains about 50 per cent. of water, which was once steam, and was taken as such from the steam-boiler. Before condensation of this steam occurred, this steam occupied a certain space, and moreover helped (on account of its heat) to expand the bulk of other gases used in the formation of sulphuric acid. In winter time the yield of acid is better, and the consumption of nitre less than in summer; and the greater the chamber space (*i. e.*, the smaller the volume of gas allowed to pass the chambers in a given time), the less will be the comparative consumption of nitre, and the easier will be the conversion of all sulphurous into sulphuric acid. Hence, adds Dr. Crookes, as the lowering of the temperature of a gas implies the shrinkage of its volume, both of which favor the process of sulphuric acid-making, Mr. Sprengel commenced to manufacture sulphuric acid by means of what has been called "pulverized or atomized water or spray," which he injects into the chambers as a substitute for steam. This

effects, first, a saving of fuel equal to the amount which is required to convert this pulverized water into steam; and, second, a cooling of the chambers equal to the loss of the amount of heat which would have been generated by the combustion of the coal thus saved. To form this spray an atomizer is employed, in which a small body of steam is made to escape from a platinum jet, under a pressure of about two atmospheres, into the centre of a flow of water. With this device, twenty pounds of steam will convert eighty pounds of water into the finest spray. The jets are arranged in the sides of the chambers about forty feet apart. They are supplied with water from a tank above, while the steam is taken either from the steam-pipes already existing between the chambers, or from smaller ones put in their place. The saving in coal effected by the introduction of this simple device is estimated by a large manufacturing company that has employed it for some time to be two thirds of the quantity formerly burned; or, to estimate it differently, the savings in steam, acid, nitre, and labor during three months amounted to five shillings per ton of acid.

The following bleaching processes are recorded by Braekebusch, who refers to the fact that the methods generally in use are not satisfactory. (1.) Cotton and linen tissues are brought in contact with oxide of zinc dissolved in lye of potash or soda. In this process there is no bleaching, properly so called. The oxide of zinc combining with the textile fibre merely masks the natural color of the latter, or perhaps forms colorless compounds with the coloring matters present. In connection therewith, it is noted that the alkaline liquids employed may affect the tissues. (2.) It has been proposed to bleach wool and silk by immersion for an hour in a solution of one part common salt, and one part oxalic acid, in fifty parts of water. The influence of the oxalic acid is certain, though unexplained. (3.) Tessié du Motay takes about equal parts of the permanganate of soda and of sulphate of magnesia, and dissolves them in lukewarm water. The tissues, previously freed from grease, are immersed in this bath until they are covered with a brown coating. They are then placed in a bath of sulphuric acid at four per cent., and rinsed after the brown matter is removed. They may be finally passed through

sulphurous acid. (4.) Ramsay's bleaching bath is formed by sprinkling with water equal parts of chloride of lime and sulphate of magnesia, by which process the hypochlorite of magnesia is produced. This last process is highly spoken of.

Upon the subject of ozone, Dr. Hofmann offers this stimulus to investigators in his late "Report on the Development of the Chemical Arts during the last Ten Years:" "How great would be the influence of a cheap source of ozone upon manufactures appears at once from the fact that in the nascent state this body oxidizes nitrogen to nitric acid. The presence of the latter body in thunder-rain has long ago been found to result from this circumstance. The manufacture of ozone would therefore involve nothing less than the synthesis of this important mineral acid, obtained hitherto only from nitre. That in grass-bleaching and in disinfection by means of ethereal oils we have from time immemorial made use of ozone—generated in the one case by the growth of grass, and in the other by the hydrocarbons—can only serve to intensify our longing for the technical production of ozone." Dr. Hofmann refers also to the fact that the first patent for the application of ozone was recently granted in England, for the purpose of forming acetic acid from alcohol without fermentation. The inventors (Turner and Vanderpool) obtain ozone by blowing air through a flame, and bringing it in contact with a current of alcohol. A very similar process for obtaining ozone was patented in this country, it may be added, by Dr. Loew, but no account of its practical application has thus far transpired.

The *Chemical News*, in its notes from foreign sources, affords the following information concerning Hofmann's process of utilizing iron pyrites. It is well known that the sulphur employed in the manufacture of sulphuric acid was formerly obtained from Sicily in its native state. In consequence, however, of the considerable increase in the export duties levied thereon during the last twenty years, the attempt was successfully made to supersede the sulphur by iron pyrites. The extraction of these pyrites is only found profitable where they occur in large masses. The residues likewise contain such large proportions of iron (about forty

per cent.) as to entail large losses therefrom by the works, while the quantities of the same are so great as to render it difficult to find room for them. Dr. Hofmann has devised the following process for utilizing them on a large scale: The residues undergo a systematic washing, the temperature of the water being about 40° C. (104° Fahr.). To the washings thus obtained salt is added in the proportion of one equivalent for each equivalent of sulphuric acid present in the liquid. The result is sulphate of soda, which is separated by cooling and crystallization. This product has numerous industrial applications, especially in the glass trade and in the soda manufacture, and it is obtained in the present case in quantity sufficient to cover the cost of all the operations. The mother-liquors remaining after the sulphate of soda has been separated contain zinc chloride, salt, sulphates of iron and of zinc, and a further quantity of sulphate of soda. By concentration to 54° B., the various salts are deposited with the exception of the zinc chloride, which may then be separated. It has several well-known industrial applications, and commands a good price. Or it may be worked for metallic zinc, by being first treated with lime to convert it into zinc oxide.

The residue containing the iron originally present in the pyrites, still impurified with some sulphur, is dried for some days in the open air, when the bulk thereof crumbles to powder, though there remain also compact fragments. With regard to these masses, Dr. Hofmann has observed that the pulverulent portions are almost free from sulphur, which is almost completely contained in the more compact fragments. A simple process of sifting suffices to separate the portion free from sulphur, which is then ready for metallurgical treatment as an iron ore.

Professor Henry Wurtz has succeeded in devising a very practical gravimetric method of gas analysis as a substitute for the volumetric methods generally employed. The method which he recommends — and which he has developed with special reference to the investigation of illuminating gases—is founded on the general principle of submitting a slow current of the gas to be investigated to the action of a series of agents, so selected and combined as to absorb and separate in succession, each by itself, the different proximate

constituents of a gaseous mixture, converting each into a solid or liquid form, in which condition they can be weighed on a balance. Professor Wurtz alludes in his memoir to the fact that gravimetric methods for gas analysis were successfully employed by chemists some thirty years ago, and expresses his surprise that so little has been done to develop their capabilities. The general outline of his method is about as follows: In a crude coal gas, as drawn from the hydraulic main, the gas-chemist should be able to separate and determine with precision the following: (1) Tar, suspended in the form of spray; (2) Water, do.; (3) Water, as vapor, dissolved in the gas; (4) Naphthaline (condensible); (5) Other condensible hydrocarbons; (6) Smoke and soot (with dust); (7) Ammonia; (8) Carbonic acid; (9) Sulphureted hydrogen; (10) Carbonic oxide; (11) Oxygen (intermixed air).

Of these eleven proximate constituents, Professor Wurtz affirms that he has succeeded in separating with very satisfactory sharpness Nos. 1, 2, 3, 6, 7, 8, 9, and 11, eight in all, besides approximating to No. 4 the naphthaline in excess. Nos. 5 and 10 are still subjects of experiment. The following are the devices and manipulations employed: First. Arresting suspended matter by means of empty dry flasks, and straining through cotton previously desiccated. Absorbing next the ammonia, by means of re-agents which act on no other ingredient. Next, drying the gas with calcium chloride, which, ammonia being absent, may now be done. Next, taking up the sulphureted hydrogen by a normal metallic salt, so selected or so managed as to give up no water or acid vapor to the desiccated gas. Next, using sodic hydrate to absorb the carbonic acid, with certain precautions. Next, alkalized pyrogallol, or other suitable agent, to absorb oxygen, arranged so as to lose no water. The final (rough) measurement of the gas is then made at an observed temperature by a gas-meter. The whole process is finally completed by a process of distillation, either at the ordinary or higher temperature in a current of the same gas analyzed, that has been subjected to similar treatment, and thus freed from all the ingredients to be separated from each other. After final weighings, the correct initial volume of the gaseous mixture is calculated

from certain formulæ derived from the crude meter-indications and the final weighings. For further details, we refer our readers to the memoir in full (vide *Journal of the Franklin Institute*, Vol. LXIX., p. 146 *et seq.*).

Schering affirms that the burning of glycerine may be readily effected in any form of lamp which permits the flame to be brought directly above the surface of the combustible. A long wick will not afford a steady flame, because of the sirupy consistency of the glycerine. The flame of glycerine is, like that of alcohol, very slightly luminous; and as the latter is of great utility as a solvent, Schering was induced to experiment with the glycerine flame, with the view of substituting the latter for the alcohol flame for laboratory and other purposes. The results obtained were quite satisfactory.

The assertion of Raoult, that pure cane-sugar in aqueous solution, and with the complete exclusion of air and ferments, would gradually undergo inversion under the influence of light, has been called in question by Kreussler, who has repeated the experiment with every possible precaution. The last-named chemist asserts that a pure sugar solution, kept in glass tubes, the open ends of which were drawn out and sealed with the blow-pipe, after the air contained therein had been completely driven out, failed to respond in the slightest degree to Fehling's test for glucose. Where the air had not been completely excluded, however, the contents of the tubes upon examination indicated the conversion of from 52 to 90 per cent. of the cane-sugar into grape-sugar.

Albumen for printing purposes is said to be becoming scarce, and a new source of supply is greatly needed. The debasement of silks by foreign admixture, if we may infer from the comments of journals devoted to textile interests, has of late reached such a height as to promise shortly to rival that of a class of cotton-goods which have added largely to the notoriety, if not to the fame, of one of the manufacturing centres of England. A writer to one of the French journals shows that the weighting of black silks—which began with the modest aim of making up for the loss sustained in ungumming—is now carried to the extent of 100, 200, and 300 per cent. This increase of weight is effected by treatment with salts of iron and astringents, salts of tin and cy-

anides. The bulk is augmented proportionably to the weight. The same writer points out very clearly the evils attending this excessive adulteration. The chemical and physical properties of the silk thus treated are materially modified. What is sold as silk is, in reality, a mere agglomeration of heterogeneous matters devoid of cohesion, held together temporarily by a small portion of silk. The strength and elasticity of the fibre are likewise reduced. From being in its natural state one of the most stable of substances, and but slightly combustible, in its adulterated state it burns like tinder if touched by a flame. It is likewise affirmed to be liable to undergo spontaneous decomposition, and to absorb gases with the evolution of heat which sometimes leads to actual combustion. The adulterated silk when burning scarcely gives off the characteristic odor of animal matter.

It is of interest to supplement our notices in last year's *Record* of the artificial production of vanillin—the active principle of the vanilla bean (which is now a commercial operation)—by reference to a suggestion for obtaining it largely by another process. In several manufacturing operations pine-wood is treated in iron boilers, under high pressure, with a solution of caustic alkali. The resulting liquid contains various salts of soda, and, if the temperature has not been too great, among them the soda salt of vanillin. Experiments made with the view of establishing this fact are conclusive, its presence being demonstrated by the presence of an intense vanilla odor, which becomes more prominent when the liquid is treated with an acid and left standing for several days. It has thus far, however, been found impossible to extract the crystallized vanillin from the above-named liquid, though in all likelihood this consummation will not be long delayed.

M. Gerard gives the name of Apparatine to a colorless, transparent substance which he obtains by heating starch, or substances rich in starch, with caustic alkali. The product resulting from this treatment is said to be excellently adapted as a dressing for all kinds of textile fabrics—cotton, woolen, or silk—to which it imparts a velvety gloss impossible to obtain by any other mode of treatment.

M. Paulet's observations upon the chemical operations in-

volved in the preservation of timber, contribute materially toward the rational explanation of conflicting and often contradictory results obtained in practice. This author's investigations—lately placed before the French Academy—were devoted specially to the examination of the destructive action which takes place in wooden railway sleepers injected with sulphate of copper. It is generally held that the protective action of metallic salts is due to their combination with the ligneous tissue, and especially with the nitrogenous matter, which is rendered insoluble and poisonous to living beings. This operation the author claims to be insufficient. He affirms, from his studies of the action of metallic salts, and especially of sulphate of copper, upon the nitrogenous matter of wood, that the albumino-cupric precipitate is not absolutely insoluble in water, and that it is especially soluble in water containing carbonic acid. The nitrogenized matter in wood is partly soluble and partly insoluble. The soluble albuminous portion is fixed by the metallic salt, which combines also with the insoluble nitrogenous matter. The water, especially if charged with carbonic acid, destroys and removes this metallic compound; in proof of which the author gives a number of examples, which show that the copper gradually passes out of the combination and disappears altogether, giving place to the carbonate of lime. The process is explained to be as follows: The carbonate of lime contained in the ballast is slowly dissolved under the influence of the rain-water, and penetrates gradually into the wood, substituting the copper. So long as the copper remains in its original combination, its preservative action continues. The carbonate of lime is not a septic agent, but it eliminates the preservative body from its compounds, and restores the matter to be preserved, if not to its natural state, at least to one which facilitates the access and the action of destructive agents. This theory is confirmatory and explanatory of the fact, long established by observation, that railway sleepers, etc., are destroyed most rapidly in calcareous soils; and the affirmation of the imperfect insolubility of the albumino-metallic precipitate, is additionally confirmed by the fact that the injection of timbers with metallic compounds has been found to afford but little protection to the same where they are immersed in fresh or salt water.

Some further comments on the methods of injecting timber with preservative compounds will be found under the department of General Technology.

It is of importance to record that Coupier's process for producing aniline colors without the employment of arsenic is being largely introduced. It appears that Coupier some time ago succeeded in producing fuchsine by the action, at a suitable temperature, of hydrochloric acid and iron in small quantities on pure aniline and nitrotoluol. Although it was demonstrated that the aniline red obtained by this method was identical with that usually manufactured, and that the yield was greater than where arsenic acid was used, the process was until lately very sparingly introduced on the commercial scale. Recently, however, we learn, the *Gesellschaft für Anilin Fabrikation* of Berlin has erected new works, where no arsenic acid is used in the preparation of colors. Not only fuchsine, but all the colors derived from it, are made, and all are warranted to be free from this poisonous agent. The company is producing from 200 to 300 kilogs. per diem, and the product is affirmed to be not only purer, but stronger than that made from arsenic acid. Being entirely free from this poisonous substance, these dyes are suitable for a great variety of industrial uses where the others have been found to be dangerous. Upon this subject the *Chemical News* expresses the hope that, the commercial success of the innovation being demonstrated, other manufacturers of these dyes will adopt the new method, and relinquish the old arsenic-acid process, which, apart from the inconveniences it has caused both manufacturers and consumers, has led to many lamentable accidents.

Eosin (from ἕως, *dawn*) is the name by which a newly introduced dye-stuff has been designated. In its solutions and upon silk it is characterized by exhibiting a gorgeous fluorescence, in which the beautiful tints of rose and garnet red predominate. It is brought into commerce in the form of a brown red powder, with a greenish, metallic sheen. It is soluble in water and in alcohol.

Delachanal and Mermet have devised a lamp for photographic purposes which effects the continuous combustion of carbon-disulphide and nitrous oxide. Riche and Bardy have investigated the photo-chemical intensity of various flames,

and give the following tabulation as the correct expression of the relative value of several lights examined, in which the intensity increases with the figures:

	Relative Chemical Energy.
Drummond-light	3
Zinc burning in oxygen	4
Magnesium lamp	5
Flame of nitrous oxide and carbon-disulphide vapor	6
Flame produced by leading nitrous oxide into that of carbon-disulphide burning in an open dish	6–7
Flame produced similarly by oxygen	7
Oxygen directed upon the flame of burning sulphur	8

From the foregoing it appears that the light produced by the combustion of sulphur in oxygen is possessed of extraordinary chemical energy, and may be applied to photographic uses with excellent effect.

Stein, in a communication upon the subject of normal weights and measures of rock-crystal, remarks that Kekulé pointed out, some time ago, the fact that all amorphous bodies, whether produced by casting, rolling, hammering, or stamping, are possessed of the tendency to go over into the crystalline condition. The molecules of such substances he regards as being in abnormal positions relative to each other, and the striving toward crystallization is the natural effort to assume the position of equilibrium. For these reasons, Kekulé objected to normal weights and measures made of metal, affirming that they could not be relied upon to remain constant; while, on the contrary, this objection would not hold good of such normals when constructed of a crystallized substance, as, for example, of rock-crystal. Recognizing the validity of the foregoing arguments, the author has had such weights and measures cut at Oberstein. To produce the measures, the pieces are cut exactly parallel with the optical axis of the rock-crystal, so that the main axis of the crystal coincides with the median line of the rod. The same rule is likewise observed with the weights, by which an unequal expansion is avoided. These normal weights and measures are manufactured at Oberstein by H. Stern, who has likewise devised a method of attaching the pieces to each other, when measures of considerable length are required, in such a manner that any alteration of the

scale of parts is not possible, and the correctness of the division, as also of the total length, may be under control. For these weights and measures a number of advantages are claimed. The considerable hardness of the rock-crystal (7) protects the weights from abrasion by usage, to which objection all weights of metal are open. The rock-crystal is even more indifferent to the action of acids and alkalies than platinum, while it is utterly indifferent to oxidation, to which weights of metal are more or less liable. Moisture has no effect upon it, since it is not hygroscopic. Rock-crystal, as compared with the metals, has a very small co-efficient of expansion, on which account the errors arising from variations of thermometer and barometer are reduced to a minimum. The weights are not objectionable on the score of expense, their cost being quite moderate. As produced by Stern, the larger weights, from 50 grammes to 1 gramme inclusive, are made of rock-crystal, the pieces having the same form as the commonly used weights of gilded brass, while the weights under 1 gramme are made as usual of platinum. Fresenius, who has examined and employed them, declares them to be admirably adapted for analytical work.

Lewin impregnates sandstones with a solution of sulphate of alumina, which he follows with water-glass. The stones thus impregnated may be polished and appear like marble. They resist the action of fire and of the atmosphere, and are well adapted both in appearance and durability to take the place of marbles. By preparing them at a high temperature the stones take on a species of glaze, which may be decorated with a variety of colors to imitate colored marbles and the like.

ANNUAL RECORD

OF

SCIENCE AND INDUSTRY.

1875.

A. MATHEMATICS AND ASTRONOMY.

THE EARLY USE OF THE DECIMAL POINT.

Mr. J. W. L. Glaisher, in some remarks on the history of the introduction of the decimal point into arithmetic, concludes that this invention must be attributed to Napier, the immortal inventor of logarithms. The earliest work in which the decimal separator was employed seems to be Napier's posthumous work in 1619, at which time it appears that he was aware of all the attributes that enable the decimal point to complete systematically our method of notation. About the same time Briggs employed a bent or curved line, for which, in printing, he substituted merely a horizontal bar drawn under the figures that were to be considered as decimals; but Napier himself has left so many instances of the actual use of the decimal point as to render it pretty certain that he thoroughly appreciated its use.—*Rep. Brit. Assoc.*, 1873, 12.

TABLES OF ELLIPTIC INTEGRALS.

The committee of the British Association, which has for some years had in hand the preparation of a list of tables and the calculation of new mathematical tables, report the completion of the tables of the elliptic functions, on which six or seven computers have been constantly engaged for two years past, under the superintendence of the Messrs. Glaisher.

These tables give the four theta functions which form the numerators and denominators of the three elliptic functions. The calculations relating to these functions have been carried to ten decimal places, and the printed results will occupy about four hundred pages.—12 *A*, X., 372.

NEW FORMULA FOR DETERMINING THE ALTITUDE FROM BAROMETRIC OBSERVATIONS.

M. St. Robert, of France, has published the concluding volume of his memoirs, among which we notice a new formula for determining the altitude for barometric observations. This formula embodies the results of Glaisher's balloon observations.

THE REDUCTION OF ELLIPTIC INTEGRALS.

From a mathematical paper by Meissel, Professor in Kiel, we take the following theorem, whose enunciation will be of interest to mathematicians. He states that in a great number of cases he has been able to represent the complete elliptic integral of the second order by means of algebraic formulæ, and demonstrates, in general, that the complete integral of the second order can be converted into a complete integral of the first order.—*Archiv der Mathematik*, LVI., 337.

THE TRISECTION OF AN ANGLE.

The problem of the trisection of a circular arc has lately been solved by Dr. Hippauf in a simple manner by means of an auxiliary curve, which may be designated as the conchoid on a circular base. This circular conchoid is the locus of a series of points found by drawing through one extremity of the diameter of a circle a series of lines, and finding, upon each, that point which is at a distance from the circumference of the circle equal to the radius. Having described such a circular conchoid for the circle an arc of which we wish to trisect, we draw the chord belonging to the latter arc, and then through the origin of the conchoid a parallel chord; this latter is equal to the chord of the third part of the arc to be trisected. Three other methods of effecting this trisection are also given by Hippauf by the aid of the same curve; and many other curious properties are found by Professor Sidler, who has shown that this conchoid may also be

described as the locus of the feet of a series of perpendiculars let fall upon all possible tangents to a circle, from a point outside the circle, and at a distance from the centre thereof equal to its diameter. The conchoid is likewise easily described graphically by a point fastened to a given circle which rolls around a fixed circle, provided that the two circles have the same diameter, and that the point be fastened to the rolling circle at a distance from its centre equal to the diameter thereof.—*Mitth. der Naturf. Gesell., Berne*, 1873, 31.

STANDARD TIME IN PITTSBURGH.

The question of the regular distribution throughout the community of standard uniform time has been well tested by Professor Langley, of Pittsburgh, who, during the past five years, has steadily extended the system of telegraphic connections between the astronomical observatory of that city and the railroads that centre therein. The magnificent new City Hall has in its turret a large tower clock, built by the Messrs. Howard of Boston, which by electrical connections is made to beat, second by second, in perfect unison with the standard clock at the observatory. A person at the latter building can, if necessary, even adjust the tower clock by telegraph, and can at any moment ascertain whether its indications are correct or not. The large bell of the tower is struck with the utmost accuracy at noon, and at every third hour throughout the day and night, and the public appreciation of the convenience and utility of the general system of absolutely accurate time is noticed in the universal comparison of watches daily at the stroke of noon. This ordinarily causes a movement so general and simultaneous throughout the city as on the one hand to amuse a stranger, and on the other hand to demonstrate how nervously anxious Americans are to secure the highest attainable accuracy in the timekeepers on which they depend for the regulation of private as well as public business. During nearly two years that the system has been in operation it is stated that there has not been any interruption from the failure of electric mechanism, and the utility of the system certainly more than justifies the expense which the city has been to in establishing this now recognized public necessity, which can not hereafter be dispensed with. In fact, the amount of time wasted

through the discrepancies of clocks and watches is very considerable, and is directly felt by each individual in the missing of appointments or the needless loss of time in waiting. On very many accounts the country throughout the whole region east of the Rocky Mountains would be benefited by the introduction of some uniform standard of time which should replace the innumerable and often erroneous "local times," and by which not only railroad, telegraph, and stock business might be managed, but which should be adopted also in governmental and in private matters.—*Description of the City Hall, Pittsburgh.*

PROPERTIES OF PRIME NUMBERS.

As the conclusion of an investigation by Goering into the "Theta" functions of Jacobi, and as an application of his results, the author shows that every prime number of the form $6m+1$ is always divisible, although only in one special way, into the sum of a simple and a triple square; and, again, that the product of n prime numbers of the form $6m+1$ can always be considered as the sum of a simple and a triple square.—*Goering, Inaugural Dissertation*, 1874, p. 382.

APPLICATIONS OF PEAUCELLIER CELLS.

Mr. Darwin has given an account of some applications of what are now familiarly known as Peaucellier cells. Among other things he illustrates the fact that it might become possible to construct by means of these a model that shall give an ocular and correct proof of the elliptic motion of the planets about the sun, under the influence of the force varying inversely as the square of the distance in that fixed point. Mr. Sylvester states that he himself had attempted the same problem, but failed.

HAMILTON'S EQUATION OF MOTION.

A decided advance in the principles of theoretical mechanics seems to have been made by Professor Müller, of Zurich, who has developed certain considerations based upon what is known as Sir William Hamilton's general equation of motion. That distinguished mathematician has shown that when a system of material points moves under the influence of forces proceeding from the reciprocal attraction and re-

pulsion of the points of the system, all the integral equations of the motions can be represented by the partial differential quotients of a certain function, called the Primary Function, of their co-ordinates in a manner similar to that in which, according to La Grange, the differential equations of the motions can be represented by the partial differential quotients of a function known as La Grange's function of the forces. The primary function of Sir William Hamilton is a complete solution of the partial differential equations of La Grange's function, as was shown by Jacobi. The integration of this differential equation was developed by Jacobi, since whose time the theory has undergone expansion in two respects, by Zipschitz and Schering, to whose researches Müller adds the following propositions: First, the sum of such changes in the primary function and in the expenditure of force as may be produced by the variations of the initial and final co-ordinates alone, is, in the variation of every motion that presupposes a force function, and neither explicitly nor implicitly contains the time, equal to zero. This proposition he designates as "The principle of Energy." Correlated to the preceding is Müller's second proposition, which he calls "The principle of Action," which may be enunciated as follows: That change of the action which is conditioned by the variation of the initial and final co-ordinates alone vanishes with the change of every motion that presupposes a force function, and does not contain the time either explicitly or implicitly. Here, as in the previous proposition, if we imagine the whole series of constantly altered motions to be run through with, they will in general be distinguished by different values of potential and kinetic force and energy; in proportion as by the mere alteration of the co-ordinates the potential diminishes, so does the kinetic increase. These propositions, which are represented by Müller in algebraic language, are exemplified by several applications. Applying the first proposition to a simple case, he by it develops the motion of the ordinary pendulum; but his most interesting results relate to the theory of heat. If according to the mechanical theory heat be considered as molecular motion, the application to this hypothesis of Müller's "Principle of Energy" leads immediately to the well-known first law of thermo-dynamics; while, if we apply to these molecular motions the theorem of

action, we arrive at a well-known equation already demonstrated by Clausius, and equivalent to the so-called second law of the mechanical theory of heat. We are thus able to derive these important laws from the original principle of Sir William Hamilton's theory of motion, and his general equation thus becomes the connecting band for the two propositions of the mechanical theory of heat.—7 *A*, XLVIII., 274.

ON THE SOLUTION OF NUMERICAL EQUATIONS.

A remarkable theorem relative to the solution of numerical equations whose roots are real is given by La Guerre. He first shows how to draw a certain curve having certain relations to the equation to be solved, and then demonstrates that if from any point whatever of this curve we draw two lines at right angles to each other, the two points where these lines cut the axis correspond to the desired roots.—3 *B*, XXXV., 457.

THE DENSITY OF THE LUMINIFEROUS ETHER.

In a paper on the heat of bodies, Puschel, of Vienna, attempts to explain this property as consisting mainly in a motion of ether identical with the luminiferous ether; and concludes that we may as the lower limit of the density of this substance consider that it must be more than one twenty-sixth billionth of the density of water.—12 *A*, X., 278.

A FINE DOUBLE STAR.

In a recent number of the monthly notices of the Royal Astronomical Society, Mr. Burnham, of Chicago, gives an account of the discovery of the duplicity of *Nu Scorpii*, which is an interesting illustration of the steady progress made in detecting new double stars. As the case now stands, the star in question is quadruple. It was, however, known to Herschel in the last century simply as a double star, whose components appeared single in his own, his son's, and all other large telescopes, up to the year 1847, in which year Jacob, at Madras, found that the fainter or companion star was itself double. In 1873, with his beautiful six-inch telescope by Alvan Clark, and favored by his own remarkably acute vision, Mr. Burnham writes that he had examined the star several times, and was impressed by an apparent elonga-

tion of the principal star in a direction nearly north and south. Professor Young, of Dartmouth College, was requested to examine it with his splendid refractor, and reported that he suspected that it was double, but could not be certain. During the summer of 1874, Mr. Burnham with his six-inch telescope, Mr. Newcomb with his great twenty-six-inch refractor at Washington, and Baron Dembowski, at Florence, with a nine-inch telescope, all nearly simultaneously were able to see that the principal star was double, and to measure the relative positions. We have, therefore, in this case a star which to the naked eye appears of the fourth magnitude, resolved by fine telescopes and sharp eyes into four stars, of the fourth, sixth, seventh, and eighth magnitudes respectively. The last-named and most distinguished observer of double stars says that "this is one of the finest multiple stars known." There are others of the same kind, but none presenting the same striking assemblage of brilliant objects within such narrow bounds.—*Burnham on Nu Scorpii.*

HERSCHEL'S CATALOGUE OF DOUBLE STARS.

It is well known to astronomers that Sir John Herschel in his later years engaged himself in collecting, arranging, and revising the previous literary and scientific labors of his life. His general catalogue of all nebulæ discovered up to 1863 was published in the Transactions of the Royal Society of London for the following year. His arrangement of all the double stars observed by his father, Sir William Herschel, was published by the Royal Astronomical Society. The last great work undertaken by him was that of collecting in one catalogue all the trustworthy observations of multiple and double stars which had been recorded up to the date of the undertaking. This catalogue, containing over 10,000 stars, together with a synoptical history of all the known observations of about two fifths of them, was completed at the time of the death of Sir John Herschel. It was bequeathed to the Royal Astronomical Society, at whose expense it has been recently published. This important work will be welcomed heartily by those astronomers and amateurs interested in double-star observations. It unfortunately does not contain any indication of the magnitudes and distances of the double stars of which it treats, but, by giving the positions in right

ascension and north polar distance of every known double star, it becomes a valuable aid to those who may be searching for new ones, or to those who wish to add to our present knowledge of these interesting subjects of observation.—*Mem. of Roy. Astr. Soc.*, XL.

ORBIT OF A DOUBLE STAR.

The double star, 70, *Ophiuchi*, which consists of a bright yellow star of the 4½ magnitude, and a rose-colored star of the sixth magnitude, was first observed by Sir William Herschel in 1779, and has since formed a favorite subject of observation for observers in both hemispheres. Some computations based on these observations have lately been made by Flammarion, in order to determine the apparent orbit and, if possible, the true orbit of this sidereal system. Flammarion's results are practically identical with those of Klinkerfues, as deduced a number of years ago. Flammarion, assuming the parallax as determined by Krüger, concludes the distance of these stars from the earth to be 1,400,000 times that of the sun, and the actual distance of the two stars from each other to be somewhat less than the distance of Neptune from the sun. The relative movement of the stars is, according to Klein, 1.65 that of Neptune and the sun. The two stars have, however, a common movement through space, which is three and a half times as great as their orbital velocities about each other.—19 *C*, VIII., 46.

THE ORBIT OF THE DOUBLE STAR "MU BOOTIS."

Among the theses published by the University of Kasan, in Russia, is an investigation into the orbit of the double star *Mu Bootis*, by Venogradski. Observations of this star have been made since 1782, when it was first observed by the elder Herschel; and its orbit has been investigated once previously by Wilson, but the computations of Venogradski take precedence, inasmuch as he has had access to very accurate and long-continued observations of Otto Struve and Dembowski. During the past ninety years the smaller star has described nearly one half of its orbit about the larger one; and the mutual distance has diminished from one and a half seconds to less than half a second. According to the present computation, the periodic time of these stars is about

one hundred and eighty-two years; the inclination of the orbit being 47.5 degrees, and its eccentricity 0.5. The probable errors of the measurements of the distance of the stars is scarcely one tenth of a second. According to the ephemeris published at the conclusion of the work of Venogradski, the relative movement of these stars is at present at its maximum.—*Journal of the Imperial University at Kasan*, XLI., 311.

SPECTRA OF THE FAINT STARS.

Vogel states that for some time past he has been almost exclusively occupied with the spectroscopic investigation of faint stars. Among these are some that are distinguished by having spectra which are sharply defined at the violet side, but on the red side are broken up into gradually diminishing bands. These are generally red stars. By a somewhat careful study of these spectra it seems to him undoubted that their discontinuity is only apparent, being brought about by dark bands of absorption, which, as we must assume, are the consequence of the absorption of the rays of light by the atmospheres surrounding these stars. The only rational classification of star spectra is, according to him, into the following three classes: 1. Stars whose temperature is such that the metallic vapors contained in their atmospheres can exert only a very slight absorptive effect. 2. Stars whose atmospheres, as in the case of our sun, are distinguished by powerful absorption due to vaporized metals. 3. Stars whose temperature is so lowered that the materials which compose their atmospheres can combine together. In the latter class Vogel embraces both the third and fourth types of spectra established by Secchi.—*Astronom. Nachrichten*, LXXXIV., 115.

ON THE SCINTILLATION OF THE STARS.

Montigny has lately presented to the Royal Academy of Brussels a continuation of his researches on the scintillation of the stars. In this work he has studied not only the number of bands in the spectra of the stars, but also their growth, and especially the obscurity of the lines and zones which characterize the bands. Making use of the observations of Secchi, he thinks he has been able to show with

considerable exactness the connection between the frequency of the scintillations and the characters of the spectra, having regard especially to the four types that have been proposed by Secchi. The comparison of his own and Secchi's observations leads him to the conclusion that the stars which have been chosen as showing spectra typical of the first and second classes are also those which have the most frequent scintillations. The typical stars of the fourth class of spectra are those whose scintillation is the most feeble. Those stars of the first class which scintillate less than the typical stars are in general distinguished by having less numerous spectral lines. These conclusions he subsequently finds confirmed by the observations of Huggins and Miller. His essay concludes by a calculation of the actual differences between the lengths of the routes through the air of the components of the light of any star, and this leads him to a formula which is applicable to the calculation of the relative frequency of the scintillations of various stars at different zenith distances.—*Bull. Roy. Acad. of Belgium*, 1874, 300.

THE STRUCTURE OF SOLAR SPOTS.

The study of the solar spots has very wisely been made a matter of especial attention at the observatory of Allegheny City, Pennsylvania, and Professor Langley, the director of that institution, has the credit of having published the finest photographs and engravings that have ever yet illustrated the subject. From the very cautious wording of a recent communication from him, we gather that among the typical characteristics of the solar phenomena he has observed the following new points: 1. The filaments both of the penumbra and of the umbra are all disposed in curves, which partake of the spiral type, bearing witness to the existence of a force directed toward the centre of the spot; but it does not appear that a uniform direction of rotation prevails, since some of the filaments turn to the one, and some to the other direction, while some have a distinct double curvature. 2. The filaments grow progressively brighter toward their extremities, no matter whether they are long enough to reach from the photosphere to the edge of the penumbra, or whether they are shorter than this. 3. He finds the blackest part of the spot to be intrinsically very bright, and its reddish-brown

masses are by his telescope resolved into filaments analogous to the penumbral ones, being disposed in curves, and having brighter extremities, as if their ends curled upward. Langley sees no evidence of crystalline forms, but judges rather that we seem to look down through increasing depths of transparent whirling vapor, visible objécts growing fainter till lost to sight at an unknown depth below the surface. The striking forms seen in the solar atmosphere are, he thinks, most nearly typified by certain rare types of cirrus clouds in our own atmosphere. In very many spots Mr. Langley recognizes the movement of one stratum of solar atmosphere over another.—4 *D*, IX., 192.

AGREEMENT OF SECCHI'S VIEWS WITH PROFESSOR LANGLEY'S.

The very beautiful solar drawings published in the American and Italian journals by Professor Langley, of Allegheny City, together with the announcement of the conclusions reached by him from his study of the solar spots, has called forth some remarks by Secchi, of Rome, in which the latter seems to claim a certain amount of priority in respect to the ideas of Langley, and to maintain that they agree with each other to a very considerable extent. This, however, can only be true in case Secchi relinquishes certain of his long-held theories, and it is, therefore, important to put on record his conversion to the views of Professor Langley.

WHITE LINES IN THE SOLAR SPECTRUM.

Mr. Hennessy writes, from Massorie, to Professor Stokes, that he has observed in the solar spectrum certain white lines for whose existence he is unable to account. He can not think that these are due either to the instrument or to the latitude of the station. The white lines in question can not be described as absolutely white, yet they closely resemble threads of white frosted silk held in the sunlight. They are best seen about noon.—7 *A*, XLVIII., 305.

PHOTOGRAPHS OF STELLAR SPECTRA.

Mr. Lockyer, in a recent lecture on spectrum photography, gives great prominence to the admirable labors of Messrs. Rutherford and Draper in New York City, stating that the latter gentleman has not only taken the most perfect photo-

graph of the solar spectrum yet obtained, but has succeeded in getting an admirable photograph of the spectrum of a star. It will thus become possible to study any changes that may take place in the constitution of the stars or the sun by the comparison of these photographs with such others as may be taken at some future time.—12 *A*, X., 255.

ZÖLLNER'S THEORY OF THE SOLAR SPOTS.

The theory of Zöllner as to the constitution of the sun and its spots has been thus described by him: The sun is a glowing liquid body, surrounded by a glowing atmosphere; in the latter, at a certain distance above the fluid surface, there floats a covering, constantly renewing itself, of shining clouds, like our own cumuli. At those places where the cloud canopy is thinned, or dissipated, there arise on the glowing surface, by reason of powerful radiation, the slag-like products of cooling. These, therefore, lie deeper than the general level of the shining clouds, and form the nuclei of the sun spots. Above these cooled regions there are formed descending currents of air, which give rise to a circulation of the atmosphere around the edges of the islands of slag, to which circulation the penumbra owes its origin. The cloud-like results of condensation, which are formed within the region of this circulation, have their shape and temperature determined by the nature of the circulation itself, and must, therefore, in consequence of their lower temperatures, appear less brilliant than the other portions of the cloud canopy of the solar surface, and seem depressed like a funnel, by reason of their descending motion above the spot. The exterior edge of the penumbra is at the level of the shining canopy.—*Poggendorff Annalen*, CL., 300.

ANCIENT OBSERVATIONS OF SOLAR SPOTS.

In the 29th volume of the meteorological observations at Lyons, France, an account is given of some early observations of the solar spots made by Father Beraud. In 1741, on the 8th of April, he observed eight pretty large spots on the sun. From the 16th to the 30th a remarkable spot fixed his attention. It was composed of an obscure portion of irregular form, situated between two black points, the whole enveloped by a brown cloud composed of small black

points. The whole had a round form, whose apparent diameter was 55 minutes of arc, or three times the diameter that the earth would appear to have if placed at the same distance.—13 *B*, III., 134.

THE SOLAR ATMOSPHERE.

Zöllner has published in detail his defense of his views as to the nature of the solar spots, basing his reasoning principally upon laws announced by Kirchoff in his investigations of the solar spectrum. He first shows that if the lowest strata of the solar atmosphere radiate as intensely as they absorb, clouds in that atmosphere will be scarcely distinguishable, so far as any difference of brightness is concerned between them and the neighboring atmosphere; and, secondly, he states that it is not sufficient to assume the existence of clouds, but that some reasonable cause must be assigned for their continued existence for weeks and months. In his exhaustive analysis he shows that local cooling can not be explained by conduction of heat, and that, therefore, up-rushing or down-rushing currents of cooling gas can not be produced by this cause. The influence of radiation being thus the only resource left, he draws analogy between the solar spots and the formation of dew in the earth, and seeking those circumstances under which the radiation from the surface of a body is localized for the longest time, he finds that such radiation proceeds most freely when the body is a solid; hence he concludes the solar spots to be of a solid nature.—*Poggendorff Annalen*, CL., 298.

THE DIMENSIONS OF THE SUN.

Some of the results of the studies of Secchi having been severely criticised by Anwers, he has recently edited a work by Father Rosa, which will, in part, serve as an answer to these criticisms. The investigations of Rosa and Secchi are based upon observations made during the past hundred years at Greenwich, Dorpat, and Königsberg, and Secchi believes that they show that the body of the sun must be considered as consisting of two quite independent masses, viz., a solid nucleus, surrounded by an atmosphere of gas. Instead of the solid nucleus, we may also understand the central portion to be a mass of gas in such a state of condensation that it is

to a great extent independent of its lighter envelope. The photosphere, according to these authors, is subject to periodical variations, which are not directly due to the force of gravitation. The force which specially deforms the photosphere is intimately connected with that which affects the secular movement of the centre of gravity of the sun, as has been shown by Le Verrier. The secular changes of the photosphere and of terrestrial magnetism are subject to a simultaneous oscillation of sixty-six and two-third years, similar to that equal period to which the perigeum of the apparent solar orbit is subject.—19 *C*, VIII., 33.

ON SOLAR RADIATION.

One of the most comprehensive investigations into the subject of solar radiation is that recently published by the Rev. F. W. Stowe, based on five years' observations at twenty-five stations, with the black bulb maximum thermometer in vacuo, freely exposed to the sun and air at the height of at least four feet. By the amount of solar radiation, he understands the excess of the reading of the solar thermometer above that of the ordinary maximum thermometer placed in a double-louver screen. Incidentally he mentions that the solar thermometer seldom reads above 140° Fahr. in England, and that 134° is the highest temperature on his records. The radiation attains its maximum in May. This is to be attributed to the prevalence of northerly winds, and consequent dryness of the atmosphere. December is the month of least radiation. In this statement we take account only of the maximum amounts of radiation during clear days in those months. The western stations in England show more radiation than the easterly ones. The neighborhood of the sea appears to somewhat diminish solar radiation during the summer, which he attributes to the fact that the air from the sea is, for the most part, heavily loaded with vapor during the summer season. The excess of radiation at western stations, he is inclined to attribute to the greater purity and coolness of the air, and its freedom from haze. As regards secular change, he found the radiation decidedly in defect in the early summer of 1870, but in excess in 1872, a result which may have resulted from the presence of a colder stratum

of air in unsettled weather, and in part, also, from increased reflection from the clouds. In speaking of the defects of the solar thermometer as a means of measuring the intensity of solar radiation, he states that when a perfect actinometer is proposed for general use by meteorologists, the blackened bulb in vacuo must give place to it; but in the mean time it is the best instrument that can be used for ordinary observations. Among the defects experienced in the use of this thermometer is its liability to be influenced by reflection from neighboring bodies. The reflection from the illuminated side of a cloud is very great. In this respect, Mr. P. Harrison stated that he was able to confirm Mr. Stowe's conclusions.—*Quar. Jour. Meteor. Society of London*, II., 205.

SOLAR RADIATION.

At the physical observatory at Montsouris, near Paris, regular observations are made of the radiation of the sun by means of a simple actinometer. If the atmosphere were perfectly diathermanous and the days of uniform length, the average power of the sun, allowing for its varying distance, would be the same throughout the year, and may be placed at 100°. But through the influence of the variable amount of moisture and cloud, and the variable lengths of the days, the actinometric power varies; and, according to the observations at Montsouris, while it is theoretically in December about 31°, and in June 77°, of our arbitrary scale, it was actually observed to be in December 29°, and in June 68°, showing that the earth received during those months in 1873 and 1874 slightly less heat than the average.—19 *C*, VIII., 114.

STUDIES ON SOLAR RADIATION.

M. Desains has attempted to resolve an important meteorological problem: viz., to determine the total weight of the vapor of water contained in the atmosphere in a given region. He has made preliminary observations at Lucerne and Rigi Culm, and from these he deduces the absorption of solar heat due to a thickness of one centimeter of water. He states that, by a long-continued series of observations of a similar kind, he hopes to be able to compile hygrometric

tables which will give, for any observed intensity of solar radiation, at two stations, the corresponding total weight of the vapor of water contained in the entire atmosphere. At Paris he finds, for instance, that for equal thicknesses of air its diathermancy varies from $\frac{5}{10}$ to $\frac{8}{10}$, which variations are greater than those which would have been obtained by interposing or removing a screen of water one centimeter thick.—2 *B*, XXXIV., 230.

MEASURING THE CHEMICAL ACTION OF SUNLIGHT.

Dr. Phipson says that many years ago he made some experiments on the measurement of the chemical action of the solar rays, and described an accurate method of effecting it. Having discovered that a colorless solution of molybdate of ammonia in sulphuric acid became greenish blue when exposed to the sun, and colorless again during the night, and that the amount of chemical action exerted to produce this tint may be accurately determined by using a dilute solution of permanganate of potash, he suggests that, in order to possess a perfectly accurate process by means of which to determine the chemical intensity of solar light, we have only to expose always the same quantity of the substance to the light for the same period of time, and then determine the tint produced therein by the action of the sun's rays.—18 *A*, XX., 124.

THE TEMPERATURE OF THE SUN.

The two methods of making the measurements of solar heat may be described as the dynamic method and the static method. The former is that on which the pyrheliometer of Pouillet is based; in which method a thermometer is exposed alternately in the shade and in the sun. In the static method the thermometer remains permanently subject to solar radiation; until the temperature indicated by it becomes stationary, at which time the temperature of the thermometer and that of the inclosure are noted. The principle on which the static method is founded has been investigated by Vicaire, whose results have lately been further modified and improved upon by Violle, who shows how to take account of the diameter of the bulb as well as its own radiation; he has made investigations into

the temperature of the sun, the radiation of the sky bordering the sun, and the general absorption of the solar atmosphere.—7 *A*, XLVIII., 158.

VARIABILITY OF SOLAR TEMPERATURES.

Mr. Blandford, of Calcutta, gives the results of his studies into the variability of solar temperatures as indicated by the maximum black bulb in vacuo solar thermometer. Mr. Blandford's investigations are based upon observations made from 1868 to 1874 at stations in India, and his results seem very striking, if not absolutely conclusive, as to the direct variation of the solar heat with the number of the spots and prominences. The absolute maximum temperature of the sun seems, according to his diagram, to have been reached in February, 1871. Unfortunately the highest sun temperatures recorded by his thermometers occurred not on days that were cloudless, with a very dry atmosphere, but on those in which there was a considerable proportion of cloud and frequent rains. The effect of the heat reflected from the edges of the cumulus clouds upon his thermometers seems not to have been duly considered by him.

THE TEMPERATURE OF THE SUN.

An improved method of investigation to determine the temperature of the sun has been put in execution by Violle, who describes his apparatus as consisting essentially of two concentric and spherical envelopes of brass. In the centre of the interior one is the bulb of the thermometer, while between the two envelopes a continuous current of water circulates. The exterior surface is highly polished, while the interior surface of the interior sphere is covered with lampblack. The experiment is conducted by first determining the temperature shown by the interior thermometer without exposure to the sun and then the temperature as shown during the exposure to the sun and after it has become stationary under the influence of the solar rays. The conclusions that can be drawn from this apparatus depend upon the employment in succession of different thermometers and different apertures of the diaphragm which allows the solar rays to fall upon the thermometer. Violle has made a very careful investigation into all the influences which can affect

the indications of the thermometer, and from some preliminary experiments finds that the temperature of the sun, after making the correction for the absorption of the terrestrial atmosphere, is 1354° Centigrade.—7 *A*, XLVIII., 236.

THE TEMPERATURE OF THE SUN.

We have already mentioned the interesting researches of Violle upon the measurements of the temperatures of the heavenly bodies, and have now to record a preliminary but very approximate result arrived at by him for the temperature of the sun, the correction being made for the absorptive influence of the earth's atmosphere. He defines the true temperature of the sun as that which must be possessed by a body of the same apparent diameter as the sun in order that, endued with an emissive power equal to the mean emissive power of the sun, it may emit in the same time the same quantity of heat as the sun. The observations made by his instrument, described in the previous note, by a method which he characterizes as the dynamic method, have enabled him to determine the emissive power for heat of steel after fusion, just as it issues from the Martin-Siemens furnace, and he finds it corresponds to a temperature of 1500° Centigrade. If now we assume that the mean emissive power of the sun is sensibly equal to that of steel in fusion, we arrive at the value of 2000° Centigrade for the true temperature of the sun's surface.—7 *A*, XLVIII., 396.

REFLECTING POWER OF THE PLANET MERCURY.

Zöllner has extended to the planet Mercury a series of photometric observations similar to those made by him some years ago upon the moon. The observations made, upon two especially favorable evenings, gave him, for the relative brightness of Jupiter and Mercury, the ratio 2.7 in one case, and 3.2 in the other. A comparison of the peculiarities of the results for Mercury and the moon leads him to the conclusion that Mercury is a planet whose superficial condition very nearly agrees with that of the moon; that also, like the moon, it probably possesses no atmosphere. The reflecting power, or albedo, of Mercury is the least of all the planets, and even less than that of

the moon. Zöllner also makes a very ingenious attempt to determine the albedo of the earth, and the law of the variable intensity of the light that will be exhibited by it, in its various phases, as seen from a distant planet. Concerning his attempt to determine this albedo through observations of the dark limb of the moon, he states that, although the results can scarcely be accepted as having much accuracy, they nevertheless show the practicability of the method.—19 *C*, 1874, 150.

THE ATMOSPHERE OF VENUS.

Lohse has investigated what would be the effect and appearance of a spherical gaseous mass passing over the solar disk as seen from the earth, and has sought to apply his result to the possible effect of the atmosphere of Venus on the phenomena of the Venus transit. In conclusion, he states, with reference to the so-called black-drop phenomenon, that if the atmosphere of Venus has a density so great that it unites the solar rays in one point lying between Venus and the earth, it must then have the same effect as an opaque body—that is to say, the solar limb will by this atmosphere be broken or indented before the body of Venus itself touches it; and, conversely, the solar limb will not regain its integrity, at the close of the inner contact, until the atmospheric layer is entirely within the solar disk. It is possible that, at the inner contact, this effect of the atmosphere of Venus contributed considerably to the appearance of the so-called black drop.—19 *C*, 1874, 170.

THE VISIBILITY OF THE PLANET VENUS.

Professor Safarik, of Prague, endeavors to explain the intense brightness of Venus, and particularly the dazzling splendor of her bright limb, without assuming specular reflection on the surface of the planet. He remarks that the intensity of the phosphorescence of the sea in our tropical waters is not fully appreciated by the near observer, who therefore has only a faint idea of the intensity which this phenomenon can acquire under highly favorable circumstances, and the author thinks it not unreasonable to suppose that such a phosphorescence can be seen even at the

distance of Venus. If so, it explains the fact that the edge of the dark limb of Venus is seen brighter than its central part; for it is demonstrable by calculation and confirmed by observations that a rough surface reflecting diffused light appears the brighter the more obliquely it is regarded.—*Report Brit. Assoc.*, 1873, 408.

THE TIDAL RETARDATION OF THE EARTH'S ROTATION.

In some remarks on the various causes that operate to retard or accelerate the earth's daily rotation, Mr. Mallet remarks that if we take into account all the operations at work upon the earth's surface, such as the flowing of rivers down hill into the ocean, the carriage of great masses of earth, as mud, from the upper sections of the earth to the bottom of the ocean, the fall of raindrops, the flow of rivers from low to high latitudes, and all other similar seemingly insignificant causes, we shall find no reason to suppose that the retardation of our globe by tidal friction, whatever may be its actual amount, can go on unchecked until the earth is brought to a stand.—7 *A*, XLVII., 40.

THE MASS OF JUPITER.

Powalky has attempted a new determination of the mass of the planet Jupiter, by examining its perturbing influence on the movements of the asteroid Virginia (No. 50). The result to which he is led indicates that the mass of Jupiter should be increased by about one two-hundred and seventy-second part of the present adopted value; but although this correction enables him more nearly to satisfy the observations that have been made upon Virginia, he is yet inclined to attribute to it only a slight value, and hopes to attain better results by a repetition of his work in future years.—*Astron. Nach.*, LXXXIV., 71.

THE SATELLITES OF URANUS.

An interesting study has lately been made by Professor Holden, of the Washington Observatory, on the observations of Sir William Herschel upon the satellites of Uranus. It is well known that the latter astronomer announced sixty years ago that Uranus was accompanied by six satellites; but of the existence of four of these there has always been

considerable doubt, since no one was ever able to confirm the observations of Herschel. In 1847 Lassell discovered two interior satellites, which were, however, different from those which Herschel suspected; and since that day the four problematical satellites of Herschel have been generally discarded by astronomers. Professor Holden now brings testimony to the high excellence of Herschel's observations, as, by computing backward, he has shown that probably this distinguished astronomer actually observed the two interior satellites of Lassell (named by him Ariel and Umbriel); but that he was unfortunately prevented from identifying them as satellites because his telescope could not show them on two successive nights. The extreme difficulty of observing these objects makes us wonder at the marvelous skill and patience manifested by the elder Herschel in this laborious research, which was carried on by him from 1787 to 1810.—*Bull. Phil. Soc. Washington, Appendix* IV.

ORIGIN OF AEROLITES.

During the last two or three years the discovery of energetic forces of eruption on the sun has demonstrated the occasional occurrence of convulsions so violent that they may suffice to project molten and gaseous matters to distances beyond the sphere of the sun's attraction. The existence of such forces and the evidence which the microscope affords that aerolites have had their origin among mineral masses in a state of fusion, if not of vapor, combine to support the theory, formerly entertained by other writers and recently announced very definitely by Mr. Proctor in England and Professor Kirkwood in America, of the astro-meteorological hypothesis of the origin of meteors and meteorites.—*Report Brit. Assoc.*, 1873, 400.

THE GREAT COMET OF 1684.

The investigation of the great comet of 1684 forms the subject of the inaugural dissertation of Professor Neugebauer of the University of Breslau. This comet belongs to those which, on account of the close approximation of their orbits to the earth's orbit, have attracted the attention of Professor Schiaparelli as worthy of scrutiny in connection with shooting-stars. The only accurate observations of the comet of

1684 that have come down to us were made during two weeks at Rome by Bianchini; and in order to derive from these the best possible results, Neugebauer has reduced them all anew, by using the best materials available, he having access to original letters and drawings still in existence. The observations made by Bianchini were of the simplest kind; for instance, he would hold a stretched thread in such a position that, while it covered some one of the known fixed stars, it nearly covered the comet itself, whose position, relatively to the ends of the thread, was then estimated by the eye. Other and more exact observations were made with the help of rude instruments. The relative positions of the comet, as deduced by great labor, in general seem to be trustworthy to within a few minutes of arc, and Neugebauer's elements of its orbit are not greatly different from those given by Halley. It follows, as the most interesting result of the investigation, that on the 18th of June, 1684, the distance of the comet from the earth was only the hundredth part of the distance of the earth from the sun, being, in fact, only the thirtieth part of the distance of the earth from Coggia's comet on the 21st of July, 1874, when it was nearest the earth. It seems, therefore, that the orbit of the comet of 1684 approaches more nearly to the orbit of the earth than almost any other known comet, and that under favorable circumstances we shall be justified in expecting some meteoric display yearly about the 18th of June, at which time the earth annually comes into the plane of this comet's orbit.—*Inaugural Dissertation, Breslau*, 1873.

THE PHENOMENA OF COMETS.

As the result of a suggestive paper by Faye on the forms of comets, he states that he has been led to conclude with perfect certainty that cometary phenomena reveal to us in the heavens the existence of a second force totally different from attraction, and capable of playing an important part, and producing before our eyes gigantic phenomena; that, with great probability, this force is nothing less than the repulsion due to heat. In order to demonstrate experimentally the existence of such a repulsion (which is mathematically deducible from the dynamic theory of gases), he advises the following arrangement: A jar of very rarefied air is il-

luminated by means of the spark of an induction apparatus; the glass bell-jar in which the vacuum is to be made is traversed by the two wire conductors of the apparatus, the one vertical and the other horizontal, and the induction spark itself appears in the form of feebly luminous rays, whose colored stratifications surround the horizontal conductor with a luminous sheath of a well-marked blue color. The horizontal wire having been made of a thin plate of platinum, an independent electric current is passed through it, so as to render it red-hot, and immediately the blue-colored sheath of rarefied air is repelled from the red-hot platinum plate. After having made all possible variations of this experiment, he concludes that it demonstrates a repulsion between the heated platinum and air.—12 *A*, X., 289.

THE CONSTITUTION OF COMETS.

Mr. Lockyer briefly reviews the state of our knowledge as to the spectroscopic observations of comets. In general, observers seem to agree that these bodies consist, in part at least, of not very dense incandescent vapor, while in some cases very dense or possibly very complex vapors, or even glowing solid substances, seem to have been present. Huggins first suggested the idea that the rarer cometary vapors might be composed of nitrogen, but subsequently suggested the theory that a comet is composed of carbon, and that a temperature prevails high enough to volatilize a portion of this substance, giving rise to the three bands coinciding with those of olefiant gas. Mr. Vogel has, however, shown that this is a very questionable theory, and that we are only justified in concluding that a portion of the light emitted by the comet is its own light, and very probably comes from glowing gas. Mr. Lockyer, moreover, found the nucleus of Coggia's comet deficient in blue rays, whence its temperature must have been low, which conclusion is further justified by the fact that cometary light gives channeled space spectra, which latter are peculiar to low temperatures.—12 *A*, X., 180.

THE FORMATION OF THE TAILS OF COMETS.

The distinguished Italian astronomer, Schiaparelli, has communicated to the journal of the Italian Spectroscopic Society some studies upon the nature of the repulsive force which

contributes to the formation of the tails of comets. The actual existence of this force is established by the accurate observations that have been made. He examines successively the various theories that have been put forth—the electrical theory as proposed by Zöllner, the molecular theory of Zenker, and the theory of Faye that repulsion is exerted by all incandescent surfaces, and that thereby the gaseous matters attending the comets are repelled from the surface of the solid nucleus. The latter does not seem to Schiaparelli to afford any material explanation of the phenomena. The electric theory was first suggested by Olbers, but has been in general terms objected to by Herschel, Lamont, etc. Zöllner's views have been elaborated more minutely, and he has endeavored to show that the free electricity existing upon the surface of the earth is sufficient to produce an effect similar to that found in comets; but his conclusions are in too many respects at variance with actual observations to allow the author to consider them as affording a reasonable explanation as to the nature of comets. Zenker's views are rejected by him for the reason that the evaporation of fluids from the surface of the nucleus should give rise to several phenomena not seen in comets, while, on the other hand, it does not explain the multiple tails which have frequently been observed. In conclusion, Schiaparelli thinks that we are forced to believe that the repulsive force acting upon comets is a force exterior to the comet itself, and since this force evidently operates in the direction of the radius drawn from the comet to the sun, therefore we must regard it as having for its origin the sun or some medium surrounding the sun, and he adds that this is about all we at present know upon the subject.—3 *B*, XXXV., 263.

WINNECKE'S COMET.

The comet known as Winnecke's comet is a very faint telescopic comet, whose recent appearance was observable by only a few of the largest telescopes in the world. It was first observed in 1819, but attracted no notice until in 1858 it was again observed by Winnecke. From the observations made at that time, Winnecke showed that it accomplished its revolution in its orbit in about 2400 days, and that it was identical with the comet of 1819, having made seven

revolutions about the sun since that time without having been observed. Its short period of revolution gives it an additional interest; its movement seems to have experienced no disturbance in the course of the two revolutions that it has made during the past fifteen years.—13 *B*, III., 174.

ON THE REPULSIVE FORCES OF COMETS.

Schiaparelli has recently published his views upon the cause of the peculiar phenomena exhibited by comets, views which he has entertained and in part published since 1862, during which time, on the other hand, he has taken so prominent a part in the development of our knowledge of shooting-stars. According to Schiaparelli, there actually exists a repulsive force, not only between the sun and the tail, but also between the particles composing the nucleus and the tail of a comet; and the phenomena exhibited by these bodies can not be explained without assuming these repulsive forces. In fact, if we consider, first, the formation of the tail itself, we shall find that the solar gravitation and the movement of the comet do not suffice to explain it, as has been abundantly testified to by all who have minutely examined the observations that have been made. Again, too, if we consider the tail itself, and its path in space, we shall find, as has been shown by Bessel in reference to Halley's comet, and by Pape and Bond in reference to Donati's comet, the existence of a repulsive force repelling the comet from the sun results with as much certainty as the movements of the earth prove the existence of an attracting force toward the sun. The third comet of 1862, on the other hand, whose tail was not projected in a direction opposite to the sun, but continually approached this direction as the comet moved away from the sun, shows that the repulsive force acts upon the particles of the tail as well as upon the nucleus of the comet; that, in fact, the tail was first sensibly brought under the influence of the sun after it had been projected from the nucleus of the comet by a force residing therein. Under a minute examination, the head of a comet sometimes shows beams of light projected from the nucleus, but subsequently turning back and forming portions of the tail, so that here, also, the existence of the repulsive force is apparent. Finally, the increase in the breadth of the tail as it separates from the

nucleus shows that the repulsive force is exerted, not only between the sun and the tail, but also between the separate atoms of which the tail is formed. Since, thus, repulsion is proved, and even apparent as we may say, we must attach some value to the determinations that have been made by Bessel, Pape, and Bond, who were obliged to make certain hypotheses as to the development of the tail, while, on the other hand, the third comet of 1862, like many others, seems to have developed its tail in such a manner that we have at present no safe foundation for computing the amount of the repulsive force existing therein.—19 *C*, VIII., 109.

PECULIAR AURORAL PHENOMENA.

The nature of the auroral light is the subject of a communication by Lemström, who concludes that the white flaming appearances occasionally seen on the summits of mountains in Spitzbergen and in Lapland are of the same nature as the northern lights. Similar appearances have also been seen in other parts of the world. Electrical currents that develop themselves in the earth when the auroras are present are not induction phenomena caused by the atmospheric auroral currents, at least not in northern regions.—19 *C*, VII., 383.

THE SPECTRUM OF THE AURORA BOREALIS.

The late Professor Angström, who at no time accepted the theory that the spectra of gases varied with the pressure and temperature and chemical process, advanced the opinion that the spectrum of the aurora borealis is composed of two different superposed spectra, the one consisting of extremely feeble bands of light, belonging to the spectrum of the negative pole, the other consisting of a single strong yellow line, which is characteristic of the aurora, and which, Angström believed, owes its origin to fluorescence or phosphorescence. —12 *A*, X., 211.

THE GEOGRAPHICAL DISTRIBUTION OF AURORAS.

In a recent paper in Petermann's geographical notices, Professor Fritz, of Berne, gives the results of his researches into the geographical distribution of auroras. Having as far as possible eliminated the sources of error arising from the

fact that few observers preserve complete records of the aurora, and that few records which continue over a number of years have a uniform degree of completeness at all times; having also eliminated the periodic changes, both the diurnal and the annual, and after making allowance for the relative cloudiness of the different stations, Fritz presents a map compiled from the records for upward of two hundred places in Europe, Asia, and America. He discusses with great care the probable value of the observations, and then draws lines of equal frequency of auroral display, or isochasms.

The zone of maximum frequency is a narrow belt passing just north of the North Cape and the Siberian coast, through the northern part of Spitzbergen, and near Point Barrow, Great Bear Lake and Nain on the coast of Labrador. According as we go from this zone northward or southward, we come to regions of gradually diminishing frequency and diminishing intensity of auroral display; and it is important to observe that, while south of this zone of maximum frequency the auroral arches are generally seen north of the observer, they appear to stations on the north of it to be south of the observer's zenith, while to those upon the zone they appear indifferently to the north or south. The whole system of belts deduced by Dr. Fritz has very great similarity to, and almost coincides with, those given by Muncke in 1820, and by Loomis in 1856. The curves of equal frequency generally cut the magnetic meridians at right angles, and apparently follow the borders of the continents and the limits of perpetual ice; upon which fact Professor Fritz seems inclined to dwell with special attention, and to conclude therefrom that the atmospheric electricity produced by the friction of winds blowing over ice-fields has something to do with the exhibition of the aurora. It has been suggested, in carrying out the same idea, that it may not be unlikely that the aurora varies with the increase and decrease of the ice, whence, by analogy, it may be concluded that the neighborhood of the Alps may influence the frequent displays of aurora seen in Northern Italy.—12 *A*, XI., 14.

GROUND CURRENTS AND THE AURORA.

In some remarks on the auroras of February 4, 1871, and 1872, Mr. Tarry states that it appears from the observations

made at the telegraph bureau at Brest that magnetic and telegraphic disturbances preceded, accompanied, and followed the apparition, which was a visible but, in fact, only secondary part of the phenomena. The aurora borealis is in reality a magnetic storm, as defined by Humboldt, and it is only by the study of the changes experienced by terrestrial magnetism during these apparitions that we shall come upon the true cause of the phenomenon; moreover, inasmuch as the magnetic disturbances are always recognizable long before the appearance of the aurora, we can easily predict the latter. The disturbances of terrestrial magnetism have probably a cosmical cause, and it is impossible to study them properly except throughout the whole world simultaneously.—*Nouvelles Meteorologiques*, p. 36.

THE CELESTIAL INDICATOR

Is the name of a pretty piece of apparatus, patented, we believe, by Mauperin, of Paris. It is designed to enable one to determine instantly the name of any star or constellation by simply pointing in its direction with the indicator of the instrument. The apparatus consists essentially of a tripod stand supporting a circular table, which may be inclined at any angle to the horizon. On this table is engraved a map of the stars, and its circumference is divided into degrees and the divisions of the year. From its centre there stands up a column which revolves about its axis, and supports at its top a pointer. This pointer is movable about its centre in a plane perpendicular to the table, while in a horizontal direction it carries a second pointer, fixed at the base of the column, and therefore in close contact with the map of the stars. It of course follows that when the upper pointer is directed toward any stars, and the star map is properly oriented for the day and the hour, the lower pointer will then cover the star in question, and its name may be read on the chart. A lantern attached to the table illuminates the chart sufficiently, so that the whole stand may be carried out of doors and used there with convenience. The indicator may also be used for the inverse process; that is, for making charts, and, perhaps with advantage, may be employed by observers of shooting-stars and auroras. It might also, at least in principle, be extremely convenient

to those who are engaged in drawing and studying the clouds.—*Bulletin Hebdomadaire*, XVI., 25.

ON THE ERRORS OF MICROMETRIC MEASUREMENTS.

In the course of an excellent series of measurements of the relative positions of the stars in the cluster of Sobieski's Shield, Professor Helmert has made a determination of the so-called personal errors in micrometric measurement of position angles. As Otto Struve and Dembowski are the only astronomers who have as yet thoroughly investigated this important source of error, the results of Helmert's observations are especially valuable. The apparatus used by the latter can easily be applied to any telescope, and will, it is hoped, be frequently applied by others. Helmert concludes that there was possibly in his case a gradual change in his method of observation, and that when this is eliminated there still remains a periodical error in his measurements of angles, which, although much smaller than that of Otto Struve, is quite similar to it in its general features.—*Publications of the Hamburg Observatory*, No. 1, p. 19.

ASTRONOMICAL WORK WITH THE GREAT MELBOURNE TELESCOPE.

From the proceedings of the Royal Society of Victoria we learn that during the past five years Mr. Ellery, of the Melbourne Observatory, has examined the positions of 38,000 stars. The great reflecting telescope, of four feet aperture and forty feet focal length, has been employed in examining the star Eta Argus and its surrounding nebula. The spectrum of this star is found to be crossed by bright lines, which seem to indicate that hydrogen, nitrogen, sodium, and magnesium are present—no dark lines having been seen with certainty, though they were suspected. Considerable changes have, however, occurred in the spectrum, if we may judge from a comparison of the records of 1869 and 1874, since in the latter year no bright lines were to be detected, while a distinct nebulosity surrounded the star, which had formerly appeared projected on the black background. The nebula surrounding this star is evidently subject to great changes. In the spectrum of Jupiter absorption lines constantly appear. An examination of the small stars near

Sirius shows, besides Alvan Clark's companion and that of Lassell, eight others within a distance of one minute of arc. —12 *A*, XI., 90.

THE GERMAN NAUTICAL OBSERVATORY.

It may be known to some of our readers that since 1868 there has existed in Hamburg a private institution representing the combined nautical and meteorological interest of that city. The control and support of this institution has lately been assumed by the German Government under the following regulations, among others: By the name "Deutsche Seewarte" an institution is established whose problem shall be to further the knowledge of the ocean, so far as this is of interest to navigation, as also that of the phenomena of the weather on the German coasts, and to utilize this knowledge for the safety and expedition of navigation. The Seewarte is located at Hamburg, and has under it nine observing stations and forty-five signal stations along the German coast. The annual appropriation for the entire establishment and its dependencies is 75,000 marks.—7 *C*, XI., 130.

THE FIXED HORIZONTAL TELESCOPE OF LAUSSEDAT.

The Siderostat is the name given by Foucault to the perfected form of the apparatus originally used by Laussedat for photographing the sun. It consists essentially of a clock-work by means of which rotation is given to a mirror, and so uniform and smooth is the movement that for hours together it follows the diurnal movement of the stars with such perfect accuracy that an observer looking into it sees reflected any sidereal object, which latter appears stationary to him while the mirror is moving. Great labor has been spent upon this instrument by Foucault, who has designed it, and by Eichens, who has recently finished its construction. This instrument, as mounted at the Paris Observatory, has been in constant use in experiments in photographing the sun; in fact, it ought to be the indispensable auxiliary of physical astronomy, since it allows the observer to direct his spectroscope or photometer, or other apparatus, steadily in the same direction, viz., toward the mirror, which latter only moves and reflects the sun's rays directly into the optical apparatus.—12 *A*, X., 358.

DIVISIBILITY BY SEVEN.

Professor Brooks, of Millersville, Pennsylvania, presents a number of curious rules relating to the divisibility of numbers by 7, of which the most general expressions are as follows: Any number divided by 7, 11, or 13 leaves the same remainder as is obtained when the sum of the odd numerical periods, minus the sum of the even numerical periods, is divided by these numbers. The converse of which is that any number is divisible by 7, 11, or 13 when the difference between the sum of the odd and even numerical periods is divisible by these numbers.—*The Analyst, July*, 1875, II., 129.

THE VARIABILITY OF TERRESTRIAL LATITUDES.

In a memoir on the determination of the latitude of the Royal Observatory of Capodimonte, at Naples, Fergola, after calling attention to a source of error in the instrument used by Brioschi in 1820, as in fact had previously been done by Peters, states that he has employed in his own more recent determinations one of the instruments employed by Brioschi himself, but has used it in an entirely different manner; and has, in fact, employed it only for determining the differences of the zenith distances of stars in the meridian north and south of the zenith. He states, as is so frequently done nowadays, that this method is originally due to Captain Talcott, of the United States Army; in which statement, however, Fergola has fallen into an error, as Horrebow and Hell had already applied this method over a hundred years ago, as have also numerous European astronomers since that time. The special interest that attaches to Fergola's new determination of the latitude of Naples consists in this, that his result is over one second smaller than that of Brioschi; and he calls attention to the fact that quite similar differences will be found in the latitudes determined at various times at the observatories of Greenwich, Washington, Milan, and Rome. —*Vierteljahrssch. Astron. Gesellsch., April*, 1875, X., 60.

SIMPLE METHOD OF DETERMINING LATITUDE.

A method of determining latitude without instruments, and with a considerable degree of approximation, is given by D'Avout; and, as it may sometimes be useful to travelers, we

repeat it with some detail. Given a horizontal plane; above this plane, upon the same vertical and at known distances, are placed two points, whose shadows upon the horizontal plane can be followed. Around the common projection of these points, as a centre, two arcs of circles are described, whose radii are such that they can intersect the traces of the shadows of the points themselves before and after the meridian passage of the sun. The observation consists in measuring the chords of the arcs obtained by joining the intersections of the traces of the shadows with the circles; knowing the length of the chords, the radii of the arcs, and the heights of the points whose shadows are observed, we can, by a simple formula, calculate the latitude of a place. Either the two points whose shadows are projected may be two spheres, fixed upon the same vertical thread which traverses their centres, or we may use small circular openings pierced in metallic plates, and placed so that their centres are found on the same vertical. The shadows of these objects are small ellipses, whose centres may easily be found. The variation in the declination of the sun, between the afternoon and morning observations, occasions only a very small error, its effect being, in great part, eliminated from the final formula. The errors that may be made in measuring the various data above enumerated can occasion very small errors in latitude. The principal source of error is a possible want of exact horizontality in the plane on which the shadow is cast. In fact, an error of about two degrees in the inclination of this plane may produce an error of one degree in latitude. If, however, the plane be horizontal in a north and south direction, but incline in an east and west direction, the effect of the latter inclination may be neglected. The elimination of this latter source of error is due in part to the adoption of two points and shadows. The same advantages do not inhere in the employment of one point and one shadow.—*Bulletin Hebdomadaire*, XV., 578.

DETERMINATION OF LATITUDE AND TIME.

In a communication on the method of determining the time by means of two observed altitudes of any celestial body, Vice-admiral Von Wullerstorff-Urbair states that the method of determining the latitude by means of observations

of stars, at equal zenith distances, was proposed and applied by him in 1848, at the Naval Observatory in Venice, but has in later times been widely adopted, and is known in America as Talcott's method. Admiral Von Wullerstorff-Urbair shows that the same system may be applied with accuracy to the determination of time; and quotes a note from Palissa, at the Naval Observatory at Pola, who says that this method was applied by him in December, 1873, and gives results whose value is equal to those deduced from the transit instruments. The method is specially to be recommended to travelers, since by means of the same theodolite both time and latitude may be accurately determined. The formulæ given by Von Wullerstorff-Urbair seem scarcely so convenient in practice as those taught for many years past by Dollen and the Russian geographers, and which were published in full some years ago by Smysloff.—"*Mitth.*" *Austrian Hydrogr. Off.*, II., 129.

THE COMPUTATION OF THE AREAS OF IRREGULAR FIGURES.

There often occurs a necessity for determining from a drawing the superficial contents of planes bounded by curved lines. This is the case, for instance, in the determination of the superficial contents of the water-lines of vessels. In such computations, ordinarily, we employ somewhat rude approximations, as in Simpson's or Stirling's methods. The latter author has given two methods: the first depending upon the principle that the portion of a curved line, between any two ordinates, may be considered as a portion of a parabola of the second degree. In the second method, given by the same author, the curve is considered as a portion of a parabola of the third degree. These three methods may be supplemented by other methods depending upon formulæ developed by Gauss, Cotes, and others. But in general all these methods are somewhat more difficult of application than that known as Simpson's, which is far more frequently employed than any other. A very decidedly better way has been proposed by the Russian mathematician, Tchebitcheff, whose method is simpler than either of those just mentioned, and, although less accurate than that of Gauss, is more accurate than those of Cotes, Stirling, and others. Indeed, a greater simplicity of application than this method offers is scarcely to be demanded, and its accuracy surpasses the ordinary

necessities of the arts. In order to represent as closely as possible a curved figure by a series of polygons, Tchebitcheff takes six terms of the integral formula corresponding to six ordinates selected in the following manner: Let the surface be inclosed by the curved line A B C D, and the straight line A D; subdivide A D at E. The one half of A E, multiplied by the measured values of its ordinate, is then to be set off on either side of E, thus marking the places where new ordinates are to be measured, which are themselves to be multiplied by one half of A E; the products again set off on either side of E, and then a third pair of ordinates measured. In this way three pairs, or six ordinates, are obtained, whose values have a certain relation to each other and to the given curved line. The desired area is found by multiplying one sixth of the sum of these ordinates by the length of the line A E D. Other methods generally give results somewhat less than the truth. The method of Tchebitcheff generally gives larger results than the others.—"*Mittheilungen*" *Austrian Hydrogr. Office*, 1874, p. 530.

ASTRONOMICAL WORK AT CORDOBA.

In his annual report, as Director of the National Observatory of the Argentine Republic, for the year 1874, Dr. Gould states that the three principal undertakings of that observatory, viz., the uranometry, the zones, and the smaller catalogue of stars, have satisfactorily advanced toward their completion. An inevitable delay having occurred in the publication of the first mentioned of these works, the opportunity was seized to revise some portions of it—a revision which indicates that the accuracy attained is quite commensurable with Gould's original hopes and expectations. Having secured the necessary funds, it is now expected that in the course of the present year the publication of the charts will be completed. These will be thirteen in number, comprising the whole of the southern heavens. The total number of stars whose positions and magnitudes will be given will be not far from 8500. With reference to the zones of stars, he reports that some 12,500 additional observations have been made, bringing the total number up to 82,537. It is not improbable that the number of observations yet to be made will swell the total to more than 100,000; which work he

then (March, 1875) hoped would be completed by the end of July, 1875. The greatest hinderance to the prosecution of this undertaking consists in the difficulty of securing the services of an adequate number of trained astronomical computers.

Of the large number of stars observed in these zones, a small portion have been selected as fit to form a special catalogue of brighter stars. This catalogue includes nearly 5000 stars, and some 12,400 observations upon these were made during the year. Dr. Gould adds that not one hour of unclouded sky between sunset and midnight was lost by his assistants during the whole time of his recent visit to the United States, notwithstanding that other observations were also going on by night, and continual computations by day. The equatorial telescope has been as busily employed as the meridian circle. Coggia's comet was observed from the 27th of July to the 18th of October. Standard Cordoba time has been given regularly from the observatory without a single case of failure; and latterly the exact Buenos Ayres time has been telegraphically transmitted to that city for the convenience of the shipping. Meteorological observations have been conducted and reported regularly to the Meteorological Office. Dr. Gould's corps of assistants has consisted of four persons, with occasional aid from others competent to act as copyists and computers. The assiduity of the labors of all concerned is abundantly testified to by the record of their results.—*Annual Report, March*, 1875.

PROPERTIES OF THE TETRÆDRON.

In an exhaustive memoir by Dostor on the application of determinants to certain problems in solid geometry, we find the following theorems relating to tetrædrons: The sine of a triedral angle is equal to the product of the sines of two of its faces, multiplied by the sine of the inclosed diedral angle. Again, in every tetrædron each face is equal to the sum of the products which we obtain by multiplying each of the three other faces by the cosine of its inclination to the first face. And, again, in every tetrædron the faces are to each other in the same proportion as the sines of the supplements of the opposite triedral angles. The volume of the tetrædron is equal to one sixth of the product of three

contiguous edges multiplied by the sine of the triedral angles formed by these edges. Its volume may also be expressed as equivalent to multiplying one half of the product of two opposed edges by the sine of the angle comprised between them, and by one third of the shortest distance between these faces. In the regular tetrædron, the radius of the circumscribed sphere is triple the radius of the inscribed sphere.—*Grunert's Archiv*, LVII., 113.

ORBIT OF THE DOUBLE STAR 42, COMÆ BERENICES.

The star 42, *Comæ Berenices*, was discovered to be double in 1826 by the elder Struve, but it appeared single in 1833, since which time it has been observed regularly either by the discoverer or by his son, Otto Struve, as well as by other astronomers. Since 1826 it has four times presented the appearance of a single star, one of the bodies being actually occulted by the other. The very accurate observations of Otto Struve made since 1840, after having been corrected for the personal errors peculiar to his observations, and which have been most carefully investigated by himself, have sufficed to enable him to determine with very considerable accuracy the position and apparent dimensions of the relative orbits of these stars. The plane of their orbits coincides so nearly with the line joining them to the sun, that we can not certainly state that there is any appreciable inclination between the two. We have therefore to adopt 0° as the inclination between the line of sight and the orbit of the stars, and there results 11°, or the mean of all observed directions, as the angle between the ascending node and the declination circle. The remaining elements of the orbit of the stars, viz., the mean annual motion, the eccentricity, the major axis, the time of passage through the periaster and the angle in the orbit between the periaster and the ascending node, must all be deduced from micrometric measures of the relative distances of two stars. Observations of this nature are proverbially so difficult that up to this time astronomers have avoided employing them when position angles could be used instead. The great accuracy of Struve's micrometric observations, however, is fully illustrated by the remarkable agreement between the observed distance and those computed in accordance with the numerical values

found by Struve for the time of revolution and eccentricity, and the other elements of its orbit. Of the thirty-eight positions given from 1827 to 1874, only two cases occur in which the discordances amount to one tenth of a second of arc; and these causes, it is promised, will be, at least in part, explained away in a forthcoming memoir relating to the peculiar systematic errors that attach themselves to the observations made by Otto Struve in 1840–41. Of the remaining thirty-six discordances, eight slightly exceeded one twentieth of a second of arc. The remainder are less than that quantity. The probable error of a single observed distance or the result of a single night's work is 0.046. Observations of these stars made by other astronomers agree satisfactorily with the orbit determined by Otto Struve, although the average of the discordances is somewhat larger in their observations than in his own.—*Notices of the Royal Astronomical Society*, *May*, 1875, 372.

METHOD OF CONSTRUCTING CHARTS OF STARS.

In constructing the new charts of the stars in the neighborhood of the ecliptic, the French astronomers, under the general direction of Le Verrier, have adopted some novel and excellent methods. The brothers Paul and Prosper Henry, in that portion of the work which they have performed, have made use of two equatorials, having apertures of about nine inches, and by a duplicate examination of each portion of the heavens have been able to discover many small planets and comets. The great equatorial of the observatory has been furnished with a micrometer of special construction, in which advantage is taken of the precision with which the telescope is made, by means of the regulator of Foucault, to follow the diurnal movements of the stars. This micrometer gives immediately the co-ordinates of any star comprised in the field of view of the telescope, with reference to a given standard point, and that in such shape that these figures may be entered directly upon the chart. This micrometer is also now being applied to the mapping of the individual stars in some of the clusters. The accuracy of the work done with this instrument is such that the star places given upon the charts are reliable within a second of time and one tenth of a minute of arc: a result some-

what surprising when we consider the extent of the work and the rapidity with which it is done. A portion of the zones will cross the Milky Way, and it will be attempted to give the position of every star visible in this region with the help of telescopes of ten inches' aperture.—*Bullet. Hebdomadaire*, 1875, 335.

ON THE RECTILINEAR RELATIVE MOTION OF THE COMPONENTS OF THE STAR 61 CYGNI.

Mr. Wilson has examined the relative motion of the components of the double star 61 *Cygni*, with the intention of ascertaining how far recent measures confirm Struve's conclusions that this motion is rectilinear. If these stars were physically connected in a binary system, it would be highly improbable that their apparent motions as seen from the earth would be sensibly straight lines. And yet, during the past century, the observations, which have been numerous, show that their motions really are so. On the other hand, the fact that they both have very large proper motions, being respectively 517 and 509 seconds per century, and in the same directions, leads to the conclusion that in all probability there must be some connection between them. We have thus the remarkable phenomena of two stars close together, animated by an unusually great proper motion, yet whose physical connection is still in doubt. Mr. Wilson's studies upon this subject seem not to contribute any thing toward a solution of our present doubts. He is merely able to confirm the fact that all known observations may be sufficiently well explained by the assumption that the two stars are moving in straight lines.—*Notices of the Royal Astronomical Society, April*, 1875, 324.

THE TRIPLE STAR ZETA CANCRI.

The triple star *Zeta Cancri* has for many years formed an object of study on the part of Otto Struve, who has recently published an excellent memoir on the relative movements of its components. The first observations of this star were by Tobias Mayer in 1756, who recognized it as double, and determined the relative position of the components. Similar observations were made in 1778 by Christian Mayer. Sir William Herschel, in 1781, made the interesting discovery

that the principal one of the stars observed by Mayer was itself double; which observation was again confirmed, in 1825, by Sir James South. The three stars are nearly equal in brightness, and are ranked as between the fifth and sixth magnitudes; but whether the masses of the three bodies are really nearly the same can only be determined by their own movements, as deduced from such observations as have been made by William and Otto Struve. The former astronomer observed them first in 1826, since which time they have been closely followed by himself and son. The remarkably accurate observations of Baron Dembowski at Gallarate, near Milan, in Italy, together with those made by Dawes in England, have been by Otto Struve combined with his own; and from the entire assemblage of all the appropriate observations he finds that the apparent orbit of the star B about the star A is completed in about 62.4 years, under the assumption that the apparent orbit is circular, which appears to be very nearly the case (the real orbit has an eccentricity of 0.35). The third star of the group, indicated by the letter C, is apparently about ten times as far from A as is the star B. Its angular movement relative to the former star is therefore correspondingly slow, it having described only 47° in ninety years, while the star B has entirely completed its revolution and described a portion of its second orbit. An interesting peculiarity of the motions of the star C consists, however, in this, that its movements are by no means regular. It is in fact subject to repeated alternations within periods of about ten years, within which time it moves sometimes forward rapidly, and at other times backward, and at other times it is stationary. Its apparent orbit around the star A is therefore essentially an epicycloid; but unhappily the present state of mathematical analysis does not enable us to say whether these irregularities in its movement are due to the perturbing attractions of the stars A and B, or whether we must assume that the star C describes an elliptical orbit about an invisible point central between it and a fourth invisible star, D, while the central point itself describes a much larger orbit about the stars A and B. Otto Struve states that if we refer the positions of the star C to a point half-way between the stars A and B, we can closely represent all our observations by assuming C to move in a small

ellipse, having a diameter of a third of a second, which latter is, at a distance of 5.5 seconds, carried uniformly about the point central between A and B.—*Bullet. Hebdomadaire Assoc. Scientifique*, 1875, 217.

ON THE CHEMISTRY OF THE SOLAR SYSTEM.

Observation and theory have led Lockyer to the conclusion that the various elements constituting the sun are arranged in layers according to the atomic weight of their vapors. Thus outside of all is hydrogen, with an atomic weight of one. Then follow, in regular order, magnesium, calcium, sodium, chromium, manganese, iron, nickel, etc. At the centre the nobler and rarer metals must be found, constituting the substance of the sun. In this same order should the nebulous mass have been arranged from which the solar system was developed, according to La Place's hypothesis, consequently the exterior planets of the solar system should be principally formed by the condensation of the metalloids, and the inferior planets be composed of the metallic elements; thus Lockyer explains the feeble specific gravity of the former, and the greater mass of the latter planets. The composition of the atmospheres of the planets, which give only a few rays of absorption in the spectrum, seem to confirm this view of Lockyer. Even the composition of the outer shell of the earth would seem to accord therewith, since it is formed in the following proportion: Oxygen, 500; silicium, 250; the other metalloids, 227; and of other simple bodies, 23 parts out of a thousand. If, on the other hand, we add the liquid portion of water, it will be found that hydrogen enters in a still larger proportion, and, with oxygen, acquires a predominance; so that it may be said our earth is composed principally of oxygen and hydrogen, with a small percentage of metals and metalloids.—*La Nature*, III., 206.

A FAMOUS SOLAR ECLIPSE.

The total solar eclipse of the 3d of June, 1239, was a memorable event in Central Europe, and has formed the subject of an interesting memoir by Celoria, one of the astronomers at the Observatory of Milan. This gentleman has collected together all the accessible notes with reference to observations made at that time upon the eclipse, from

which it appears that the line of central totality passed through Northern Italy and Southern Spain. Our author has sought, by a very careful discussion of the observations at command, to determine the precise northern limit of visibility of the total eclipse; and, by comparing the observations with the tables of Hansen, to deduce some positive addition to our knowledge of the secular changes in the orbit of the earth and moon. He expresses his results by an equation which shows that we need but one more similar eclipse in order to arrive by means of a second such equation at more correct elements of the lunar orbit.—*Publication of the Royal Observatory, Milan*, No. 10, 1875.

STUDIES UPON THE DIAMETER OF THE SUN.

As the extensive work of Father Rosa upon the solar diameter is likely to provoke much further investigation of this subject, notwithstanding all that has been done by Auwers, Wagner, Newcomb, and many others, we quote the following conclusions to which he has been led, as published in the posthumous work recently edited by Father Secchi. First, the body of the sun must be considered as composed of two masses nearly independent of each other, viz., of a solid nucleus enveloped by a gaseous matter. The expression "solid nucleus" can even be applied to the central portion of a gaseous mass whose condensation is such that it is necessary that it should be nearly independent of its envelope. Second, the deformations of the photosphere are not due directly to the force of gravity. Third, the continuous force, that which especially deforms the photosphere, is connected with that which produces actual secular movements of the centre of gravity of the sun as demonstrated by Le Verrier. Fourth, the vertical diameter of the sun experiences an annual variation or a semi-annual period, such that it is greater when the sun is north of the equator. Fifth, the mechanical theory of the sun's motions demands that its centre of gravity should describe, in its apparent movement, a great circle of the celestial sphere. The centre of figure, according to Airy, describes a parallel circle, lying northward therefrom. Sixth, it results evidently from the two preceding sentences that the plane of the ecliptic is not parallel to that which cuts the photosphere into two symmet-

rical parts. Seventh, it also results that the mean accumulation which is produced at the extremities of the diameter of the photosphere takes place instantly by preference in the northern hemisphere. Eighth, it seems, then, probable that a larger quantity of the gaseous mass may be suspended in the northern than in the southern hemisphere. It must be that this accumulation occasions the excess of temperature in the northern hemisphere, and opposes therein some resistance to the manifestation of the interior activity of the sun. Father Rosa finally concludes that the secular variations of the photosphere and of terrestrial magnetism are simultaneous, and subjected to an oscillation of 66⅔ years, similar to that which the apogee of the apparent orbit of the sun is subject to. We can thus consider our sun as making a part of a triple stellar system, in which the interior star combines with our sun in a movement about the same centre, whose period is 66⅔ years.—*Biblioth. Univers.*, 1874, 259.

SOLAR RADIATION IN EGYPT.

M. Picte has communicated several series of observations which he has had occasion to make during a prolonged sojourn at Cairo, as director of the Physical Cabinet of that city, and among them he has made some measurements of solar radiation with a large actinometer. His apparatus consisted of a sort of boiler, of two thin plates of parallel sheet iron, filled with water, placed in a chest full of black cotton, and closed over its face, which was turned toward the sun, by a comparable number of plates of glass. As a result he finds that, in Egypt, a surface of one square meter exposed normally to the rays of the sun in the middle of the day absorbs very nearly twelve calories or units of heat per minute. Other observers, also operating in Egypt, have found about ten calories. The diurnal evaporation produced by the action of the sun is one sixth of an inch of water. The evaporation which is due to the dryness of the air and to the wind is one third of an inch.—*Biblioth. Univers.*, 1874, 484.

THERMOGRAPHS OF THE ISOTHERMAL LINES OF THE SOLAR DISK.

Professor Mayer announces that he has devised a method for obtaining the isothermals on the solar disk, by which in-

vention he thinks it possible that an entirely new branch of solar physics may be created. He causes the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of Meissel's double iodide of copper and mercury. When the wave of heat, passing through the carbon and the paper, has warmed the thin film of iodide to the temperature of 70° Centigrade, this substance is blackened; and if, beginning with a very small aperture of the telescope, we gradually increase it until we obtain the smallest area of blackened iodide that can be produced with a well-defined contour, we thus obtain a determination of the area of maximum temperature on the solar disk. On using a larger aperture of the object-glass of the telescope, a larger surface of blackened iodide is formed, the new area being bounded as before by a well-defined isothermal line; and by repeating this process maps are obtained of the isothermals of the solar disk. An exposure of about twenty minutes is required to obtain these thermographs, which are sufficiently permanent to allow one to trace accurately their isothermal contours. But other substances exist which are more suitable than the iodides for producing permanent thermographs. Professor Mayer states that, as far as he has at present applied this method, he concludes that there exists on the solar disk an area of sensibly uniform temperature and of maximum intensity. This area of maximum temperature is of variable size. It is in motion on the solar image. It is surrounded by well-defined isothermals. The general motions of these isothermals follow the motions of the central maximum area, but they have also their independent motions.—*American Journal of Science, July*, 1875, 50.

A NEW METHOD OF COMPUTING PLANETARY PERTURBATIONS.

The immense amount of labor that has, for a hundred years past, been spent upon the computation of the mutual perturbations of the planets, and the great amount of time and ingenuity employed by mathematicians in devising the methods of special perturbations and mechanical quadratures, would justify a prolonged notice of the new method of computing special perturbations developed in a recent memoir by Professor Gylden, of Stockholm, and which has been

applied by Backlund to the computation of the movements of the asteroid Iphigenia. The original method consists in integrating the differential equations of perturbations, according to analytical methods, instead of by mechanical quadratures; Gylden's idea appears to lead to as simple forms of computation as the older methods, but possesses several great advantages, especially in the checks upon the accuracy of the computation at every step of the process. By means of analytical formulæ developed by him some years ago as preliminary to the present work, he is able to express the coordinates as well as the sines and cosines of the co-ordinates of the perturbed bodies in rapidly converging series. Dr. Backlund, in applying Gylden's method to the computation of the special perturbations of Iphigenia, has taken account only of the disturbances introduced by Jupiter during three semi-revolutions of the asteroid. He divides the orbit of the planets into sixteen equiangular portions of twenty-two degrees each, for each of which the perturbations are independently computed.—*Vierteljahrsschr. Astron. Gesellsch.*, X., 36.

GALLE'S PATH OF THE METEOR OF JUNE 17, 1873.

The orbit of the bright meteor observed in Austria and Germany on the 17th of June, 1873, has been carefully investigated by Professor Galle. Having satisfied himself that the end of the visible path of the meteor was not far from Zittau, he made a special examination of that region, and gathered many observations which enabled him to fix the actual position of the meteor at the time of its disappearance, and was even able to gather some of those fragments which reached the earth, although their actual fall was not observed by any one, and the connection of the supposed fragments with the original mass is subject to some doubt. In the computation of the orbit, Professor Galle proceeded according to the method elaborated by him as most appropriate to such cases, as follows:

Having determined definitively the exact position of the end of the orbit, each observer's observation then enabled him to determine the apparent plane of motion, the intersection of which planes determined the position of the path followed by the body. Among the thirty-three excellent observations which he was able to use in his study, only

two or three were discordant from the others to such an extent that but little weight could be attributed to them. The linear length of the visible path in the atmosphere was sixty-two geographical miles, the initial point of which was twenty-two miles above the earth's surface, while its end was four and a half miles high. The meteor moved nearly in the plane of the ecliptic, and was approaching the sun at the time that it passed through the earth's atmosphere, cutting the earth's radius vector at an angle of forty-five degrees, the curve of its orbit being that of a hyperbola, and its velocity being somewhat slower than that of the ordinary shooting-stars. The detonation that accompanied this meteor was heard to a distance of forty miles, being most intense in the neighborhood of the end of its path, where at nearly every station it was reported as like the long rolling sound of thunder.—*Jahresbericht der Schlesischen Gesellschaft*, 1874.

TWO GROUPS OF NOVEMBER METEORITES.

Professor Kirkwood, of Indiana, communicates to the English journal *Nature* some remarks on the meteors of November 14, known as the Leonids, because their radiant point is in the constellation of Leo. According to Professor Kirkwood, there are indications of the existence of two distinct and widely separated clusters of meteors moving in orbits very nearly identical, and having therefore very nearly the same radiant point. The principal cluster is that whose appearance at intervals of 33¼ years was first demonstrated by Professor Newton, while the second group, according to Kirkwood, has a period of 33⅓ years. He suggests that if these two clusters are originally derived from the same meteor cloud, then there must have been a considerable disturbance in their orbits caused by the attraction either of Uranus or of the earth. He cites nine recorded displays of meteors indicating the existence of the second cluster. The first of these occurred in the year 288, and was observed in China on the 28th of September.—12 *A*, XII., 85.

ENCKE'S COMET.

Dr. Van Asten, already known by his profound investigations into the movements of Encke's comet, announces that, having lately come into the possession of a number of obser-

vations of this object, he hopes to deduce something definite in reference to the peculiarities of its orbit. It is well known that Encke himself believed this comet to be gradually drawing nearer to the sun, in consequence of the resistance offered to its movements by the æther existing throughout space. Van Asten, however, states that his investigations have led him to the surprising result that the observations of 1865 to 1871 can be perfectly accounted for by the general laws of mechanics, quite without calling to our assistance the attractions of unknown bodies or the resistance of an unknown æther. If, under this assumption, we reverse the problem, and attempt to deduce the movements of Jupiter from observations of Encke's comet, we arrive at a result quite identical with that deduced by Bessel, Kruger, and Moller, so that we may be certain that the mean motion of the comet, at the time of its perihelion passage in 1868, experienced not the slightest trace of an acceleration. The assumption that it did experience such an acceleration, even the one-twentieth part of that supposed to exist by Encke, leads to very improbable errors. Van Asten lays stress upon the date, 1868, and says that while at present the comet's motions are fully explicable, yet, if we extend our researches backward, it does seem highly probable that at its perihelion passages in 1858, 1862, and 1865 the comet did successively experience accelerations nearly agreeing with Encke's suppositions. The conclusion, therefore, seems reasonable that the most remarkable feature of this phenomenon is the complete absence of any acceleration at the perihelion passage of 1868; nor can this be explained on the supposition that the disturbing influence of the planet Mercury has been different from that assumed in the calculations. As there can be no doubt that the comet experiences an extraordinary perturbation in the immediate neighborhood of its perihelion, Van Asten explains that he has, for simplicity, made the preliminary assumption that this acceleration took place suddenly at that time; an hypothesis, however, which is not materially different from Encke's assumption that the comet moves in a resisting medium, whose density varies inversely as the square of the distance from the sun; for, if its density vary according to this law, its effect upon the comet would be mainly felt during twenty-five days before and after the perihel-

ion. At the appearance of this comet in February, March, and April, 1875, Bredichin, at Moscow, and Struve, at Poulkova, were successful in making observations which are best accounted for by assuming an acceleration since 1871 of about two thirds as much as that indicated at previous apparitions, as though the physical changes in the interior of the comet which occurred in 1868 had affected not only its movements at that time, but also, in a lesser degree, are continued to the present time.

ON COMETARY ORBITS.

In giving a general review of the statistics relative to the orbits of comets, Guillemin states that 177 have parabolic orbits, 73 elliptic, and 14 hyperbolic. To these must be added a large number of other comets not yet accurately computed, so that we may calculate that of these bodies scarcely one sixth are foreign to the solar system, and the remainder circulating about the sun as do the planets. With regard to the inclinations of their orbits to the orbit of the earth, he shows that the greater inclinations are more frequent than the lesser; so that the comets whose paths are confined to the zodiac form scarcely a quarter of those that are known. As regards the direction in which they move in their orbits about the sun, the direct and the retrograde motions are about equally divided. But if we examine in detail the three classes—the parabolic, the elliptic, and the hyperbolic orbits—we find that among the elliptic orbits the direct motions are twice as numerous as the retrograde. As regards the distance to which they approach the sun, 192 have come between the earth and the sun, and 66 between the earth and Jupiter; while between the orbits of Venus and Mars not less than 130 of these have passed.—*Bulletin Hebdom. Association Scientifique*, 1875, 262.

ON THE STRUCTURE OF COMETS AND METEORS.

From an examination of the gases occluded in the Iowa meteorite of February 12, 1875, Professor Wright, of New Haven, concludes that his results have an important bearing upon the theory of comets and their tails, warranting the following conclusions: First, the stony meteorites are distinguished from the iron ones by having the oxides of

carbon, chiefly the dioxide as their characteristic gases, instead of hydrogen. Second, the proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. Third, the amount of gases contained in a large meteorite, or cluster of such bodies serving as a cometary nucleus, is sufficient to form the train as ordinarily observed. Fourth, the spectrum of the gases is closely identical with that of several of the comets. We may, then, he states, consider a comet merely as a meteorite of considerable magnitude, or a swarm of many such of lesser size, containing large quantities of carbon dioxide, with some carbonic oxide and hydrogen, and giving off this gas under the influence of solar heat. The gaseous substance in streaming away forms the train which is visible, partly by reflected sunlight, and partly by its own light, due to some molecular or electrical action which causes it to give the spectrum of the carbon compounds. The loss of the gaseous contents readily explains the loss of the tail and diminution of brightness, observed in the case of several comets in their successive revolutions.—*Silliman's Journal, July*, 1875, 48.

THE DISTRIBUTION OF COMETARY ORBITS.

Guillemin calls attention in his new work on comets to a feature in the distribution of the orbits of these bodies, which consists especially in the fact that there are special regions of the heavens in which the cometary aphelia are more thickly crowded together than in other regions. Basing his studies upon those of Hoeck, of Utrecht, he places the region within which the least number of cometary aphelia is found in the sector comprised between the ecliptic and a circle inclined thereto at an angle of about 35°, and cutting it in the longitudes 95° and 243°. In explanation of this singularity, Hoeck suggests that if the point toward which the solar system is moving in its great motion of translation occupied the middle of this sector, it would follow that the comets coming from this region would have greater difficulty than any others in following and rejoining the sun. But the direction of the movements of the solar system is such that it does not favor this explanation. Guillemin suggests, therefore, that possibly this sector corresponds to a region

of the heavens essentially deficient in cometary emanations, although possibly the deficiency of cometary aphelia in this region may depend, to some extent upon the fact that the atmospheric conditions in July and December are unfavorable to the discovery of comets in that part of the ecliptic. The first of these suggestions, however, will be seen to have some probability, if we consider that Sir John Herschel, who has worked on the distribution of the nebulæ, has shown that the various regions of the heavens are very unequally favored as regards the actual quantity of nebulous matter; and a similar inequality in the distribution of those nebulous centres whence comets emanate might from analogy be reasonably expected.—*Bullet. Hebd. Assoc. Scien.*, 1875, 234.

BRUHNS ON POGSON'S AND BIELA'S COMETS.

The return of Biela's comet in 1872 was, as will be remembered, looked forward to with great interest, and some disappointment even was felt that it continued invisible to the most powerful telescopes employed in the search for it. Under these circumstances, a faint interest was awakened by the fact that on the 27th of November one of the most beautiful showers of shooting-stars was observed, and that, too, in such a position that it seemed probable that these meteors were moving precisely in the orbit of Biela's comet. There was, therefore, a strong presumption that an intimate connection existed between the two phenomena. Klinkerfues, of Göttingen, suspecting that, in fact, the two might be identical, telegraphed to Pogson at Madras, on the 30th of November, the following dispatch: "Biela touched the earth November 27. Search near *Theta Centauri.*" Following the suggestion of this dispatch, Pogson searched, and found a comet near the predicted spot, but was successful in observing it on only two days—the second and third of December; and for some time the impression seems to have prevailed among astronomers that he must have actually observed Biela's comet. His observations, however, have been carefully discussed by Oppolzer, and now recently more thoroughly by Bruhns. Oppolzer and Klinkerfues agree that Pogson's comet was really in the most intimate connection with the star shower, and possibly was really the head of Biela's comet. Bruhns, however, seems conclusively to show

that Pogson's observations can not possibly be made to agree with the orbit of Biela's comet, as computed by Michez; and that it is very probable that the object observed by Pogson is a new comet having no connection either with Biela's or with the shooting-stars.—*Vierteljahrsschrift Astronomische Gesellschaft*, X., 162.

LORD ROSSE'S THREE-FOOT TELESCOPE.

Those who are interested in large telescopes will perhaps not have forgotten that Lord Rosse has for a long time possessed, not only his immense telescope of six-feet aperture and fifty-six feet focal length, but also a smaller telescope of three-feet aperture, whose space-penetrating power must be equal to, if not superior to, that of any refracting telescope which has yet been constructed. Mr. Dreyer, in a review of the observations of nebulæ made by Dr. Schultz, states in a note that the observations of nebulæ which have been made at Birr-Castle by Lord Rosse, almost without interruption since 1860, have been, within the last few years, made, not as formerly in order to procure exact sketches and descriptions of more interesting objects, but to give measures of positions and distances of as many stars as possible in the immediate neighborhood of the nebulæ in Sir John Herschel's general catalogue. The distances are observed with occulting bars, so that the faintest stars can be observed. The six-foot reflector is, however, so mounted that the observer can follow an object near the equator only for about thirty minutes, and this causes great inconvenience in the conduct of the work they have in hand. He states that the three-foot reflector will, in a short time, be mounted as an equatorial, and will in the winter of 1875–76 be used to complete a series of special observations of nebulæ made since 1860, and whose publication may be expected in one or two years.—*Vierteljahrsschrift Astron. Gesell.* X., 66.

ON THE ELECTRIC DISCHARGES IN THE AURORA BOREALIS.

An extensive series of observations on the aurora by Lemström in 1871, during a journey into Lapland, and published recently by the Helsingfors Academy of Sciences in Finland, has become accessible to us through a translation by the author, who sums up the results of his work, and that of

others, as follows: First, the luminous phenomena, or flames, seen about the summits of the mountains of Spitzbergen, are also seen in Lapland, and are of the same nature as the aurora borealis. Second, some phenomena of the same kind, although a little different, have been observed in other countries; and this proves that electric discharges of the nature of the aurora can take place elsewhere than in the arctic regions. Third, the spectroscope is the surest means of deciding, in case of doubt, as to the nature of the phenomena. Fourth, in arctic countries the electric discharge preceding thunder passes through the atmosphere at a lower altitude than in any other countries. Fifth, the electric currents which are developed in the earth when the aurora takes place are not phenomena of induction governed by the latter—at least not in the northern regions. If they are not caused by the same current which is produced by the transportation of electricity from the upper regions of the atmosphere toward the earth, it is necessary to seek their cause in the perturbation of the terrestrial current. Sixth, in all probability the currents attending the aurora should be able to affect the galvanometer, provided that the apparatus which collects the electricity is sufficiently large, or placed sufficiently high in the atmosphere. Seventh, as a rule, the positive electricity of the aurora comes from above, downward. Eighth, the corona of the aurora is only a perspective phenomenon; but the rays themselves have a real curvature. Ninth, in the spectrum of the aurora there are in all nine rays, which, in all probability, are the same as the lines given by the gases that compose the atmosphere. Tenth, the spectra of the aurora can be classified in three different types, which depend upon the character of the discharge itself.—*Bibliothèque Universelle*, L., 1874, 385.

COMPENSATION OF CLOCKS FOR THE INFLUENCE OF BAROMETRIC CHANGES.

In the new standard sidereal clock of the Royal Observatory at Greenwich, a peculiar arrangement has been introduced in order to counteract the influence upon the rate of the clock of the varying density of the earth's atmosphere. This density, as it is well known, varies principally with the changes in barometric pressure; and Professor Airy has

therefore established within the case of the clock a siphon barometer, on whose open end floats a rod whose rise and fall with the varying atmospheric pressure moves a horizontal lever at whose opposite extremity is supported a vertical magnet. The corresponding falling and rising of this magnet, which is placed directly under the pendulum, causes a variable magnetic attraction to be exerted upon the latter; so that with increasing density an increasing force of gravitation is, as it were, brought to bear upon the pendulum, thereby slightly accelerating its movements and counteracting the retarding influence of the atmosphere. Without this arrangement it was found that a fall of one inch in the barometer caused an increase in the daily rate of the clock of about three tenths of a second. The application of the graduating magnet has also had a further advantage in causing the arc of vibration to be sensibly constant at all times.—12 *A*, XI., 431, *and Ann. Rep. of Astronomer Royal.*

RESULTS OF THE AMERICAN AND OTHER OBSERVATIONS OF THE TRANSIT OF VENUS.

At the time of going to press with our last annual volume, there had not been time to obtain precise information respecting the success of the various parties sent out to observe the Transit of Venus. We therefore give now a brief account of the measures taken by our government with this object, as well as of those of other nations, and an estimate of the measure of success attained.

As our readers may be aware, the American parties were organized and sent out by a commission, composed of the Superintendent and two professors of the Naval Observatory, the President of the National Academy of Sciences, and the Superintendent of the Coast Survey. All the responsibility for the American system of observations rests with this commission, which was created partly in order to secure the harmonious co-operation of those departments of the government which took an active interest in the matter. In this respect the plan was entirely successful. Of the eight parties organized, one was an army party, in which the chief and assistant astronomer were officers of the Corps of Engineers of the army. Besides this, the same corps furnished the assistant astronomer for another party. There was also

a naval party, in which the corresponding officers were officers of the navy. The Coast Survey furnished the astronomers for two parties, and the Observatory furnished the chiefs for two more. The two remaining chiefs were distinguished civilian astronomers, each the director of an observatory.

The plan of observation adopted by the commission was in many respects different from that used elsewhere, being worked out quite independently. Its distinguishing features were that the observations should be made on the same plan at all the stations, that the main reliance should be placed on photographs of the phenomena, and that these photographs should be taken on a peculiar plan. The essential feature of the plan is that the image of the sun is thrown into the photographic dark room by being reflected from a flat mirror, the rays after reflection passing through a lens of forty feet focal length. This lens is so adjusted that the image is formed on the photographic plate, which is firmly mounted on an iron pier in the dark room. This plan is extremely convenient in photographing, and one of the best illustrations of its advantages is found in the fact that at not a single one of the stations was there any mishap which interfered with the taking of the photographs during the critical moments of the transit. Another circumstance worth noting is that the entire apparatus was of American manufacture, the most important part being made by Alvan Clark & Sons. The success of these ingenious artists with the mirrors of the photographic apparatus was especially gratifying, as it was absolutely necessary to the success of the plan that these should be made with a degree of perfection which European astronomers feared might be unattainable.

As stated in our previous volume, the Americans occupied three northern and five southern stations, an unequal division between the two hemispheres being made because the chance of good weather was much greater in the northern hemisphere than in the southern, and it was desirable to have as nearly as possible an equal number of observations on the two sides of the equator. The northern parties, with their material, were sent from San Francisco to Nagasaki by the Pacific Mail steamships, whence two of them were distributed to their stations by naval ships, one remaining in Na-

gasaki. The southern parties were distributed among the stations by the U. S. steamer *Swatara*, Captain R. Chandler, which sailed from New York June 7, 1874, and visited the five southern stations in succession.

The northernmost station was Vladivostok, a new seaport of Siberia on the Sea of Japan, lat. 43° N., long. 132° E. of Greenwich. The chief of the party was Professor A. Hall, of the Naval Observatory, Mr. O. B. Wheeler, of the Lake Survey, being assistant astronomer. The party sailed from San Francisco in the *Alaska* on July 28, and finally reached Nagasaki on August 30. Here they went on board the U. S. steamer *Kearsarge*, which conveyed them to Vladivostok. This port was established by the Russian government about 1868, more to strengthen its position in this quarter than on account of any commercial advantages. It was therefore made into a military post, with a military government. The violent winds and intense cold which prevail at this port during the winter rendered much exertion necessary to prevent the light portable observatories which the party had carried from home from being blown away entirely, and to keep the photographic house warm enough to be used. Some difficulty was found in making the instruments work well at so low a temperature as sometimes prevailed, but they were all overcome before the day of the transit. When this eventful time arrived, instead of the perfectly clear weather they had every reason to expect, the sky was covered with a thin haze, which continued during the entire four hours of the transit. In consequence it was found exceedingly difficult to obtain good photographs. Thirteen were taken; but the image of Venus is so faint that great pains will be required to determine its position with the necessary accuracy. The haziness did not interfere so much with telescopic observations as with the photographs, so that the astronomers succeeded in observing three out of the four contacts.

Pekin.—At this station Professor James C. Watson, of Ann Arbor, was the chief of the party, and Professor C. A. Young, of Dartmouth College, assistant astronomer. The record of the weather at Pekin during the month of December for a number of years showed a remarkable freedom from clouds, an entirely cloudy day being almost unknown.

The night before the transit was beautifully clear. At 4 A.M. Professor Watson went to the observatory, observed for some time, and made a final inspection to see that all was right. Every man was in his place long before the appointed time. But just as the party were taking the preliminary photographs a bank of clouds came up from the southeast and covered the sun, so that the prospect seemed almost hopeless. Fortunately openings in the clouds permitted the first two contacts to be observed, and by watching for other openings the party succeeded in securing forty-four photographs. Then it clouded up completely for a period. At one o'clock it partially cleared away, so that more photographs could be taken. But one of the most annoying peculiarities of the Pekin climate, a storm of dust, was approaching, so that the photographs were very faint, owing to the yellow tint of the sun. Still the observers succeeded in observing the two last contacts, so that all four contacts were successfully observed. This was the only American station which had this good fortune.

Nagasaki.—This was the remaining northern station occupied by the American parties. Mr. George Davidson, of the Coast Survey, was chief of the party, and Mr. Titman, of the same establishment, assistant astronomer. The weather here was much the same as at Pekin, the photographs being taken through occasional openings in the clouds. Three out of the four contacts were observed, one being somewhat doubtful. About sixty photographs were taken, most of them very thin, owing to the haziness of the atmosphere. It was somewhat tantalizing to learn that, while all three of the American stations in Asia suffered from clouds and haze during the critical hours of the transit, the German station at Tchifu, near the centre of the triangle formed by the three American stations, enjoyed a perfectly clear day.

In the southern hemisphere our commission established one station at Kerguelen Island, two in Tasmania, one in New Zealand, and one on Chatham Island. Kerguelen Island is a barren and most inhospitable mass of volcanic rocks, about 2500 miles southeast of the Cape of Good Hope. It is almost totally devoid of the higher forms of vegetable life, the most conspicuous plants being certain mosses and a so-called cabbage discovered by Captain Cook. The party

which spent three months on this barren spot was headed by Lieutenant-commander George P. Ryan, U. S. N., with Lieutenant-commander Charles J. Train as assistant astronomer. The region is one of the stormiest on the globe, and although the transit occurred at the finest season of the year, an entirely clear day is almost unknown. But on most of the days there are openings in the flying clouds driven past by the western storms, and as the station was, astronomically, the most favorable in the southern hemisphere, the chance of getting a good collection of photographs between the clouds was judged sufficiently good to justify its occupation. Although the result justified this opinion, it was perhaps a simple piece of good fortune, for storms succeeded each other in such rapid succession that the party had the greatest difficulty in keeping their tents and houses from being blown away. The *Swatara* actually lost her steam-launch in one of these storms.

On the morning of December 9 the sun rose clear, and as the entire transit was to take place in the forenoon, great hopes of success were entertained. Commander Ryan succeeded in obtaining a fine observation of the first contact of the planet with the sun's disk. But clouds then arose, and continued to fly across the sun during the remainder of the transit. By watching their chances, the photographers succeeded in getting twenty-six good photographs of Venus on the sun, so that their operations were on the whole successful.

The Germans and English also had quarters on Kerguelen Island. By an unfortunate combination of circumstances the three parties were all on the east end of the island, and so near together that they all had the same kind of weather. A year or two before the transit the English authorities had selected as their station Christmas Harbor, on the northern side of the island, which had several times been visited by their ships. The American Commission had selected Three Island Harbor, in the extreme southwestern portion of the island, principally on account of its being occupied as a sealing station by the ships of Messrs. Williams, Haven, & Co., of New London, Conn., and being as far from the English station as it was convenient to get. During the summer of 1874 the island was visited by H. M. S. *Challenger*, which ex-

amined both stations, and reported to her government that Three Island Harbor offered the best chances of fine weather, on account of being on the leeward end of the island. The change was not known to the American party until the *Swatara* reached Cape Town, where the English party had already arrived. On comparing notes it was found that both parties were bound for the same part of the island. The most tantalizing part of the result was that the station which all the parties avoided was reported to have enjoyed a beautiful day on the 9th of December.

The *Swatara* proceeded from Kerguelen to Hobart Town, Tasmania, or Van Diemen's Land, as it used to be called, and there landed two parties. One of these was in charge of Professor William Harkness, of the Naval Observatory, and the other in charge of Captain C. W. Raymond, of the Corps of Engineers, U.S.A. The latter party was designed for Crozet's Islands, a group some distance west of Kerguelen; but when the *Swatara* arrived there it was found impossible to effect a landing, owing to a sudden storm which blew the ship so far away that she could not return to the island and land the party without spending so much time as to endanger her reaching the other stations in season for the observations.

The meteorological reports from Hobart Town for the month of December in previous years had been so favorable that this was regarded as the best station in the southern hemisphere. But the whole season proved stormy in the extreme, so that it was with the greatest difficulty that the astronomers could get observations enough to rate their clocks and chronometers. At Hobart Town Professor Harkness had very bad weather on the day of the transit; indeed, there was heavy rain during a considerable portion of the time that Venus was in transit. But he succeeded in getting about ninety photographs by taking advantage of openings in the clouds, so that he had no cause to be dissatisfied with his results. Captain Raymond's party was at Campbell Town, about a hundred miles north of Hobart Town, where both the weather and the results were very much the same. Fewer photographs were obtained, but Captain Raymond secured a good observation of internal contact at egress.

The chief of the New Zealand party was Professor C. H. F. Peters, of Hamilton College, with Lieutenant E. W. Bass, of the Corps of Engineers, as assistant astronomer. The station originally designed for him was Bluff Harbor, at the extreme southern end of the southernmost large island. But on reconnoitring the ground, it was found that the chances of clear weather were better on the high lands of the interior; the station was therefore finally chosen near Queenstown. The change proved to be very fortunate. Both at Bluff Harbor, in the south, and at the English station at Christ Church, it was cloudy or raining during the whole of the transit, so that the English observers did not catch a glimpse of it, while Dr. Peters had so much clear weather as to obtain a very fine collection of photographs. But it was cloudy both at the beginning and end of the transit, so that he got only one of the four contacts.

The easternmost of the southern parties was that of Mr. Edwin Smith, of the Coast Survey, with Mr. Scott as first assistant, and was stationed at Chatham Island. This party suffered the worst of all from unfavorable weather on the day of the transit; only a few glimpses of the sun were obtained, by utilizing which the party took six or eight successful photographs.

It will be seen that the weather at the American stations was very remarkable in one point: at not a single station did the operations entirely fail through cloudiness, while they suffered, more or less, from this cause at every station. That it should have been partly cloudy at all three northern stations was a great disappointment, yet the number of available photographs in the two hemispheres is very nearly equal. The eccentricity of the weather seemed to show itself in a playful manner by favoring those places where the chances of fine weather had been found to be the least. Mr. Janssen, the celebrated French spectroscopist, who went to Japan to observe the transit, had fixed upon Yokohama as his station. On arriving there he learned that the American commission had for two years caused meteorological observations to be made at Yokohama and Nagasaki, which showed the latter to be the most favorable station. He therefore moved thither with his instruments, occupying a station two or three miles distant from Mr. Davidson's. When the day

of the transit arrived, the "probabilities" were set at defiance by the weather at Yokohama being finer than at Nagasaki.

What the public now have to look forward to is the final result of all these expeditions; and this is something which we regret to find there is no immediate prospect of learning. No nation has yet made any official publication even of its observations. The fact is that the observing parties have brought home an immense mass of material, the working up of which requires much consideration and great labor. The greatest accuracy must be sought after at every step, and any attempt to push through the complicated operations which are necessary so as to obtain immediate results would be entirely futile. In order to compare the times of the observations in the two hemispheres the longitudes of all the stations must be known. Observations for this purpose were made by the parties; but to calculate the results is a much slower and more difficult process than to make the observations. Another tedious work will be the reading of the photographic negatives. The computation of the contact observations will be easier; indeed, a French mathematician has actually published a result (8.87″ for the solar parallax) from the observations of a single pair of stations. But a result of this sort is hardly better than guess-work; and, as it is said that the other results of the French observations are different, we may fear that the above result was published only because it came out about right. Altogether, we fear it will be two or three years before the observations by each nation are worked up ready for publication; and when this is done, it will only furnish the data from which some mathematician will deduce the final result. Even then every thing will be carried through much more rapidly than in the case of the transit of 1769, notwithstanding that, owing to the more refined modern methods, the labor of working up the old observations was much less than must be devoted to the recent ones.

ON THE OBSERVATION OF VARIABLE STARS.

A second catalogue of variable stars, with valuable notes relating thereto, has just been published by Schönfeld, whose first catalogue, in 1866, with the additions of 1868, is already

well known to the few astronomers who are sufficiently interested in this subject to institute observations upon these objects. To Argelander, Schmidt, and Schönfeld is due the greater part of the credit of having advanced our knowledge of the variability of the brightness of stars to its present degree of precision. It seems to be unfortunate that so very few astronomers occupy themselves with this portion of observational astronomy, the neglect of which, in fact, seems entirely unjustifiable. The conclusions in reference to the physical condition of the stars that may be attained by observations of the variable stars are so related to those derivable from the analysis of their light made by means of the spectroscope that it is surprising that the older sister of these two branches of observation is, in these later times, so much neglected.—*Vierteljahrsschrift der Astron. Gesellschaft*, X., 74.

TIME ARRANGEMENT AT PITTSBURGH.

In his account of the very perfect arrangements at Pittsburgh for the regulation of the city time, Professor Langley states that, by the discrepancies of clocks and watches, the amount of time wasted is in the aggregate very considerable, and is indirectly felt by every individual, making it a public convenience to have a simple and universally accessible means of obtaining standard time throughout the community. The arrangements devised by him for doing this are in some degree peculiar to Pittsburgh, which is as yet in advance of all other American cities in this respect. The astronomers at the Observatory in Allegheny City having accurate time for conducting their observations, it was only necessary to secure some means by which this time could be reliably and widely distributed. Electricity was called in to do this, a current being automatically sent from the observatory clock to the large tower clock in the City Hall at every beat of the seconds pendulum, and by an electro-magnetic arrangement in the turret that clock is caused to beat in perfect unison with the standard at the observatory; it also automatically gives notice to the observatory if it is in error to any extent. At the exact second of noon a special current is sent, which raises a detent, and allows a hammer to strike the large bell at the proper instant. The public appreciation of the convenience and utility of the system is daily shown

by the attention given to the stroke at noon. During nearly two years there has not been any interruption from the failure of the electro-magnetism.—*Langley in Account of the New City Hall, Pittsburgh.*

METEORITES IN INDIA.

The details have recently been received of a very remarkable fall of meteoric stones that took place on the 23d of September, 1873, in India. The largest pieces and the greatest number fell near the village of Kahirpur, in latitude 29° 56′ N., longitude 72° 12′ E. Five stones are mentioned as having fallen at this place, but others appear to have been obtained. At a number of other places stones also fell, and the whole district over which the fall seems to have spread has a length of sixteen miles in a southeast and northwest direction, and a breadth of about three miles. Many of the stones were found imbedded in the earth at a depth of about eighteen inches. The largest three weighed ten pounds, and were very irregular in shape, and all broken. As to the composition of these aerolites, it is of the usual steel-gray color and dense crystalline texture. The specific gravity of one of the pieces is given at 3.66. The appearance of the meteor was exceedingly brilliant, and its disappearance was followed, after an interval of about three and a half minutes, by a loud report, whose long reverberation died away like distant thunder.—*Journal of the Asiatic Society, Bengal,* 1874, 34.

ANCIENT EGYPTIAN ASTRONOMICAL OBSERVATIONS.

Renouf has communicated to the Society of Biblical Archæology the result of his study of the astronomical calendar which was discovered in 1829 by Champollion near Thebes, and which was supposed by him to present a table of the constellations and their influences for all the hours of each month in the year. This calendar, which has for fifty years formed the subject of numerous publications and speculations, is now interpreted in a very different manner by Renouf, who decides that it is a record of the position of the stars in the sky at certain times in the night. It is, in fact, a table of observations, and not of astronomical calculations. Once in the course of every fifteen nights the observer ap-

pears to have noted down at each successive hour the name of the particular star which was then actually upon the meridian. We do not know how he determined his meridian, what instrument he used, or by what contrivance he limited his observations, but he seems to have noted the passage of stars over seven different vertical lines. If the star were crossing the first line, beginning from the east, it was noted down as being "on the left shoulder;" if it were on the fourth line, which represented the meridian, it was put down as "in the middle;" if on the fifth line, it was observed as "on the right," and so on. The epoch at which these observations were made is calculated to have been within one century of the year B.C. 1500. From this calendar Renouf restores approximately the Egyptian names of a number of stars well known to us at the present time. Thus *Alpha Orionis* of modern astronomy corresponds with the Egyptian constellation known as the "Goose's Head;" the *Pleiades* were known to the Egyptians as "Chu;" *Coma Berenices* was called by them "The many stars," and so on.—*Transactions of the Society of Biblical Archæology*, III., 400.

B. TERRESTRIAL PHYSICS AND METEOROLOGY.

ON THE EVAPORATION OF WATER FROM HARD AND BROKEN SOILS.

In the course of an extended investigation by Schleh into the relation between water and plants, he shows that in respect to soils that are either matted down hard or well broken up, the former elevates by capillarity the water quicker and higher than the latter. If, then, layers of disintegrated soil are placed above masses of solid earth, the elevation of the water to the upper surface from the latter stratum is checked as soon as it comes to the loose soil. As the capillary power to elevate is diminished, so also is evaporation checked by the broken character of the soil; so that, as a general result of his investigation, a soil pressed hard together loses by far more water under the daily influence of the sun and the winds than a soil similarly circumstanced, but in which the upper surface is well broken up. The experiments of Schleh therefore give exact results, entirely confirmatory of the general practice of agriculturists.—19 *C*, VIII., 136.

ON THE CONDUCTIVITY OF VARIOUS KINDS OF SOIL FOR HEAT.

A. von Littrow, as the result of investigation into the conductivity for heat of various kinds of earth, concludes that the principal influence upon the conductivity of dry soils is exerted by their mechanical constitution, the conductivity being determined by the quality, as recognized by the microscope, of those portions of the soil that can be washed away. As the fineness of the grains of the soil increases the conductivity diminishes. Organic substances diminish the conductivity, and the influence of chemical constitution disappears in comparison with the mechanical features. Wet soils conduct the heat better than dry ones; in the pores of such soil water, which is a good conductor, has replaced the air, which is a poor conductor. With some exceptions, damp soils conduct heat even better than water does. Consequently in general the materials composing the soils must, of themselves, conduct heat better than water.

The curves expressing the conductivity of dry soils lie between the corresponding curves for water and the air, while the curves for wet soils lie, in general, on the other side of the curves for water; so that the conductivity of water is intermediate between that of wet and dry soils.—19 *C*, VIII., 145.

EARTHQUAKES AND MAGNETIC DISTURBANCES.

Professor Lamont, director of the observatory at Munich, says that many cases are known where magnetic disturbances coincide with earthquakes, and states that on April 18 he by chance saw the needle of the declination instrument receive a sudden jerk, the oscillations continuing for some time. After some days he received news that violent oscillations of the needle had been observed in Parma, and subsequent computations showed that the movement had begun at the same moment in Parma and in Munich; while, later still, reports were received of a violent earthquake occurring simultaneously in Greece.—12 *A*, X., 224.

PHYSICAL AND FAUNAL RESEMBLANCES BETWEEN THE LAKES OF GALILEE AND OF UTAH.

There is some resemblance between the physical conditions of the lakes of Galilee and of Utah. Both are in mountainous regions, and are fed by mountainous streams; both are connected by a river with a larger body of salt or brackish water. They are but few degrees apart in north latitude. About the year 1864 Dr. Tristram investigated the zoology of Palestine, and determined for the first time the true relationships of the animals enumerated by Moses. He discovered that the species alluded to as the "unicorn" is the wild buffalo of the East. He brought home a fine series of fishes of the Lake of Galilee, which have been determined by Dr. Gunther, of the British Museum. Seventeen species are included in the list, which enter seven families. There is an eel, a considerable number of chubs and minnows, a cat-fish, and four species of perch. No doubt the last named constitute the more highly valued edible fishes, and may be regarded as the especial object of pursuit of Andrew and Simon Peter, and of James and John. Perhaps it was one of these that our Lord had obtained

when the apostles said, "A fire of coals burning, and fish laid thereon." In conformity with such ideas, Dr. Gunther named the species *Hemichromis sacra* and *Chromis andreæ* and *Chromis simonis*. The fourth is one with which the Jews must have been familiar before leaving Egypt, for it is the common perch of that country—*Chromis nilotica*. The fish from whose mouth Peter took a piece of money is said by mediæval writers to be the haddock, and the black spots behind the axillæ are asserted to be the marks of the toil-stained finger and thumb of Peter, miraculously preserved. As the haddock is a marine fish of the North Atlantic, and does not occur in fresh water, we are not surprised at not finding it in Dr. Gunther's list.

The fishes of Lake Utah have been collected by the naturalists of Lieutenant Wheeler's United States Survey, and number thirteen species. The number will, no doubt, be increased on fuller investigation. They are not nearly so varied in type as those of the Lake of Galilee, representing only four families. Three of these do not exist in the Palestine waters; but the fourth, the chub and minnow family (*Cyprinidæ*), is most largely represented in both. The others are of the sucker, whitefish, and salmon families, there being no perch, cat-fish, nor eels. There is but a single species of trout and whitefish each; but these go far toward supplying the economic deficiencies. The whitefish (*Coregonus williamsonii*) is a delightful table fish, and the most southern species of its family; while the trout (*Salmo virginalis*) is equally agreeable as food, and reaches a larger size. It has black spots on a silver ground, and a broad red band along the side, with red belly, red bars on the chin, red muzzle, etc. In the streams of the adjacent mountains a stouter species is found, the *Salmo pleuriticus*, which is similar in general color, but different in form, while the same crimson lateral band is seen in a sucker (*Catostomus discobolus*) which inhabits the tributaries of the Colorado River.

THE EARTHQUAKE OF BELLUNO.

The Royal Institute of Science in Venice, immediately after the news of the fearful earthquake that occurred on the 29th of June, 1873, in the province of Belluno, appointed a commission to make a thorough study of this subject.

From the report of this commission, consisting of Professors Pirona and Taramelli, it appears that the valley of Belluno is occupied by a tertiary formation, and that the earthquake shock was first felt at five minutes before five in the morning, lasting about fifteen seconds, and producing fearful destruction over the entire region. Two thirds of the city of Belluno was converted into a heap of dust. The movement of the earth-shock was from south to north, or, perhaps more correctly, from south-southeast to north-northwest. Many peculiar phenomena, such as the twisting of buildings, doors, walls, etc., took place, which have been fully explained by Mallet. Chasms were formed 200 feet long and one or two broad, but which subsequently closed. Lakes and brooks were altered, and springs dried up, while others were opened. In some springs there was noticed for twenty or thirty minutes a sulphurous taste, which, however, disappeared. No investigation appears to have been made into the location of the earthquake centre within the earth's surface.—7 *C*, X., 289.

THE EARTHQUAKE OF THE 22D OF OCTOBER, 1873.

Dr. Lasaulx has made a thorough study of the earthquake that occurred in Herzzogenrath on the 22d of October, 1873, and has found himself obliged to base his studies principally upon observations of the time at which the earthquake was felt. By means of a large number of such observations, he is able to draw curved lines connecting the points at which the shock was simultaneously felt, and thus incloses a central region directly over that spot within the earth whence the shock emanated. The velocity with which the wave was propagated along the surface of the earth was about ten miles per second. The depth of the centre was found, according to the method of Seebach, to be about six miles; while an independent computation by Professor Kortung gave a depth of three miles. It is evident, therefore, that the centre was in the solid part of the earth's crust, and the conclusion seems to be justified that the cause of the shock was the formation, or possibly the extension, of one of those cracks or faults that occur so frequently in that neighborhood, as revealed by the mining operations. A seismochronograph is described by Dr. Lasaulx, adapted to the de-

termination of the exact moment of the shock, and it is highly desirable that such a simple instrument shall be extensively employed throughout the world in the investigation of these phenomena. Professor Abbe suggests that earthquakes are not beyond the reach of the Army Signal-office predictions.—7 *C*, X., 444.

RECENT VOLCANIC PHENOMENA IN ICELAND.

During the past winter attention was directed in Norway to the falling of dust from the atmosphere, which at first was supposed to be of meteoric origin; but Professor Kjerulf decided that it was more likely to have been disseminated from some active volcano. The precise source was unknown; but from the direction of the wind, and the known conditions, it was suspected that some volcano in Iceland was concerned. This surmise has been confirmed by the more recent advices from that country, which report a very remarkable series of volcanic phenomena, first commenced by earthquakes, then followed by an eruption accompanied by dust and ashes. On March 29, 1875, the fall of the ashes was so excessive that it covered the eastern country sides, Jŏkuldal especially, with a coat six inches in thickness, and all that day, although elsewhere it was bright and sunny, the people were in absolute "pitch" darkness. Fountains and rivulets were dammed by the ashes, and every mountain stream ran dark and muddy between banks covered with drifts of ashes. The farmers fled out of the ash-covered country with their cattle, in search of pastures not yet destroyed by the *scoriæ*, but with what chance of saving their live stock does not appear.

There is no calculating the extent of this calamity, nor its effect upon the habitable portions of Iceland, although from present appearances it threatens to be extremely widespread.—3 *A*, *May*, 22, 1875, 649.

THE FIGURE OF THE EARTH.

Mr. Hind, of Nova Scotia, calls attention to the fact that the equatorial bulge of the earth's surface may have been much larger in earlier geological epochs than at the present day, and that Captain Clarke's and General Schubert's investigations, according to which the earth's equator is an

ellipse and not a circle, favor the idea that in these earlier epochs this ellipticity must have assumed the nature of a gradual change in the figure of the earth, in virtue of which a vast equatorial undulation has progressed with extreme slowness in an easterly and westerly direction.—12 *A*, X., 166.

UNDERGROUND TEMPERATURES.

The sixth report of the committee on underground temperatures states that they have made a very interesting series of observations in the great well of La Chapelle, at Paris. There was a tolerably regular increase of temperature at the average rate of one degree Fahr. for every ninety-four feet, except for the very last portion of the well, where a sudden increase appeared to take place, giving a rate of about one degree for every twenty-five feet. A very elaborate calculation has been made by the engineers in charge of the well, which has shown that a large portion of this sudden increase of temperature must be attributed to the heat generated by the operation of boring the well. The total weight of the tool employed by them is 3000 kilogrammes, and the quantity of work converted into heat at every fall of this great weight through a distance of fifteen inches is sufficient to raise the temperature of the lower portion to nearly 100° Fahr., which heat is retained at the bottom of the well for many days, owing to the feeble conducting power of the surrounding rocks.—*Report Brit. Assoc.*, 1873, 252.

"ICE CAVE" NEAR DOBSCHAU.

Dr. Joseph A. Krenner, of the National Museum of Buda-Pesth, gives an account of a visit to the famous ice cave near Dobschau, in the spring of 1873. It is located in the "Goellnitzer" valley, and is excavated in triassic limestone. From the entrance the trend of the cave is downward, a large mass of stratified ice, partly transparent, partly translucent, forming the floor of the higher and larger portions, while numerous stalactites and stalagmites of ice (the former hollow) ornament the ceiling and walls, forming at times exceedingly picturesque groups. Frozen waterfalls are found near the lower portions of the cave. The ice which serves

as a floor is so compact and so smooth as to furnish excellent skating. The water that does not freeze runs off to the lower portions into a mass of débris, and appears as a spring on the side of the mountain containing the cave. A number of observations give the mean temperature of the cave at $-0.86°$ C., while outside it was $+3.53°$ C. Dr. Krenner states various reasons why the temperature can remain so low, and thus render possible the persistence of ice, as follows: The cave has only one very small entrance, from which it runs downward throughout its entire extent; the water that is not frozen has an opportunity to flow off without stagnating, or melting the ice; the position of the entrance is such that the sun never reaches it, therefore it must be comparatively cool; a current of cold air passes upward through the cave, tending to produce low temperature.

THE DEPOSITION OF FINE SEDIMENTS.

Dr. T. Sterry Hunt states, in reference to the question of the deposition of fine mud in the Mississippi, that the deposited matter requires from 10 to 14 days to subside; but that if sea-water or salt or sulphuric acid be added to the turbid water it becomes clear in from 12 to 18 hours. Thus is explained the rapid precipitation that occurs when the river water mixes with the salt waters of the Gulf of Mexico. The cohesion of water diminishes when it holds saline matter in solution, as was said by Guthrie and was verified by Dr. Hunt. He found that the addition of eight parts of chloride of calcium to 1000 parts of water reduces the size of drops to one ninth, and the precipitation of suspended clay is made very rapid when a strong solution of salt is employed.—12 *A*, X., 277.

SO-CALLED TIDES IN GREAT LAKES.

The question of the so-called tides in the greater lakes of North America is likely to receive some elucidation from the researches of Dr. Forel, of Lausanne, who has for several years been investigating what are known as the *seiches* of the Lake of Geneva, this term being applied locally to a certain oscillatory movement occasionally seen to occur on the surface of the lake. Forel agrees with previous observers in

attributing the phenomenon to variations in the atmospheric pressure; and it is believed that it will be found to occur in all large bodies of water.

His investigations have led him to the conclusion that the *seiche* is an oscillatory undulation, having a true rhythm, and that the phenomenon is not occasional, but constant, though varying in degree. The duration of a *seiche* is a function of the length and depth of the section of the lake along which it oscillates; this duration increases directly with the length and inversely with the depth of the lake. The instrument he has devised for the investigation of the phenomenon is a "tide measurer."—12 *A*, *June* 17, 1875, 134.

SECULAR CHANGES IN THE LEVEL OF THE OCEAN.

Professor Schmick has called attention to the fact that his theory of the existence of regular periodical changes of the level of the sea, and especially of a secular movement from the northern to the southern hemisphere, is apparently supported by the conclusion of the astronomer Nyren. The latter has shown that the latitudes of all well-determined observatories in the northern hemisphere have slightly diminished since accurate observations began. This phenomenon is, according to Schmick, easily explained by the hypothesis that the water of the Southern Ocean is now about perhaps two feet deeper than it was a hundred years ago, which hypothesis accords precisely with the conclusion to which he was led by the entirely different course of reasoning published by him some years ago in his works on floods, etc.—*Gaea*, XI., 29.

TIDES OF THE EASTERN ALEUTIANS AND THE NORTH PACIFIC.

In the appendix to the United States Coast Survey Report for 1872, now in press, is a report by Mr. W. H. Dall on the tides, currents, and meteorology of the Eastern Aleutian region and the Northeast Pacific, accompanied by explanatory diagrams. Mr. Dall's observations on the oceanic currents, which are here tabulated and discussed up to the date of the report, are of special interest, as being the first series undertaken with a direct view to the solution of the problems in question, and result in the proof of there being a reflexed northerly arm of the great easterly North Pacific current, de-

nominated by him the Alaska current, which had previously been surmised from isolated observations and theoretical considerations. Mr. Dall has been able to determine the rate and dimensions of several portions of this current, and the maximum, minimum, and mean annual temperature. The existence of definite oceanic currents in the eastern half of Behring's Sea is shown to be very doubtful. Some important generalizations on the relations of the Pacific and Behring's Sea tides to each other are made, and the peculiarities of the compound tides of this region are graphically indicated by diagrams in a new method, original with the author, and possessing some interest for those studying these problems. The report is accompanied by numerous hydrographic memoranda, and tables of meteorological, current, and tidal observations.

ORIGIN OF OCEAN CURRENTS.

Mühry, in a paper on the origin of ocean currents, states that a difference of temperature in the equatorial and polar regions of the ocean is not sufficiently powerful alone to bring about the great hydrodynamic effect attributed to it, viz., the existing phenomena of latitudinal circulation. This latter is largely a result of the rotation of the earth, although the thermal circulation is frequently of great importance. He finds that the latitudinal oceanic circulation is to be considered as a duplicate one, that is, resulting from two causes working in the same direction, the one being the general diminution of gravitation toward the equator, and the other the general elevation of temperature, with its consequent expansion of the sea-water, each circulation existing by itself, independently of the others. The difference of density due to a difference in the saltness of water, according to Mühry, has no influence in the formation of currents.—*Zeitschrift für Meteorologie*, IX., 282.

THE CIRCULATION OF OCEAN CURRENTS.

Dr. Carpenter calls attention to the researches on ocean currents and deep-sea temperatures of Lenz, who accompanied the Russian exploring expedition of Kotzebue in 1823–26, and made a large number of observations of temperatures of the ocean water with thermometers whose indications were

carefully corrected for the influence of the pressure of the water. Lenz deduced the important conclusion that there is at and under the equator a belt of water cooler than the water to the north and south of it, the existence of which is explained on the principle that there must be a flow of warm surface water from the equatorial regions toward either pole, and which must be accompanied by a corresponding flow toward the equator in the lower regions of the ocean, so that at the equator itself, where the two deep-sea currents meet, cool water rises to the surface. This principle has been independently propounded by Dr. Carpenter to explain the cold band between the Gulf Stream and the United States coast, and justifies him in the statement that his own researches during the past ten years have but afforded a confirmation and elaboration of Lenz's doctrine of oceanic circulation.—12 *A*, X., 170.

NEW GENERALIZATION IN OCEAN PHYSICS.

A new generalization of much importance in reference to ocean physics has lately been derived from the observations of the *Challenger* in the Malay Archipelago during her recent passage from Cape York to Hong-Kong. The seas visited, we are told, consist of a series of sunken lakes or basins, each surrounded and cut off from the neighboring seas by a shallower rim or border. There is a general oceanic circulation down to a depth equal to that of the border, and the temperature gradually decreases from the surface to this level. The entire mass below, however, having no communication with the outer water, and consequently no circulation, remains at nearly the same temperature as that flowing over the floor of the rim; or, in other words, the water coming along the floor of the ocean from the antarctic seas, which is found in all the deep open channels, can not obtain admission through or over the rim.

On this account the bottom temperature depends entirely upon the altitude of the encircling rim. Thus, in Torres Strait, with a depth of 2450 fathoms, and a rim reaching within 1300 fathoms of the surface, the body of water below that depth has a steady temperature of 35°. The Sulu Sea, which is 2550 fathoms deep, with a rim reaching within 400 fathoms of the surface, has a temperature to its bottom

as high as 50°. The Molucca Passage, however, is open to the depth of 1200 fathoms, and the China Sea to that of 1500 fathoms.—12 *A*, *Dec.* 31, 1874, 174.

INFLUENCE OF WINDS UPON THE TIDES.

In the appendix to the recent volume of the report of the United States Coast Survey, Mr. Ferrel presents a revision of his discussion of the tides of Boston Harbor, in which, among other matters, he investigates the effect of winds and barometric pressure on the height of the tides. After comparing the actual observations with the ordinary formula for computing the heights of the tides, certain residuals remain, which may possibly be in part explained as due to the influence of the winds and the barometer. He shows that this influence varies very much in different parts of the world. Thus, at Boston, a rise of an inch in the barometer is followed by a fall of seven and one-third inches of water. At Brest, however, for the same change in pressure, the change in the water is fourteen and one-ninth inches, and at Liverpool eleven and one-tenth inches, while at London it is only seven inches, being even less than the value obtained for Boston. The direct effect of atmospheric pressure is probably to a large extent inextricably complicated with the influence of the winds. Mr. Ferrel suggests as an explanation that when the barometer is rising we usually have clearing weather on the New England coast, with westerly winds, which tend to lower the sea level; they consequently more than counteract the direct effects of inertia and friction. When the barometer is falling there are usually east winds, or, at least, an absence of west winds, and the sea level at this time is a little above the mean level. Very strong winds change the sea level in Boston Harbor a foot or more, ten such cases occurring in the course of one year.—*Report of the U. S. Coast Survey*, 1871, 94.

THE CHALLENGER OBSERVATIONS ON THE DEEP-SEA BOTTOM.

Professor Huxley, in a recent lecture at the Royal Institution upon the work of the *Challenger* expedition and its bearing upon geological problems, sums up the general results, in regard to the composition of the ocean bed, by showing that from the researches of Sabine, Ross, Penny, Ehren-

berg, Bailey, and others, it was then known that from deposits, chiefly of the siliceous cases of plants of the lowest order, the diatomaceæ, a "cap" of siliceous sand was being formed at the northern, and another at the southern pole. It was also proved that the grand areas of the general sea-bottom of the Atlantic and Pacific oceans were similarly constituted of a girdle of calcareous mud, of indefinite depth, formed by a similar vein of discarded calcareous shells of animals of low organization—the foraminifera. Now this white calcareous matter of the foraminifera shells has been shown by the *Challenger* researches to be replaced, in certain deep oceanic valleys between Tristan d'Acunha and Kerguelen's Island, and elsewhere, by a very fine red clay. In certain geological deposits, of greater or less antiquity, beds of glauconite, or green siliceous sand, exist, which are composed entirely of the casts of ancient foraminifera formed of a green material, which is a compound of silicate of iron and alumina. The chemist of the *Challenger* having found that, from the decomposition by weak acids of the calcareous shells dredged up from the 18,000-feet depths, there is a residuum of one or two per cent. of red marl, exactly like that dredged up from the 18,000-feet depths of the valleys referred to, the conclusion is arrived at that the red mud is the accumulation of this small percentage of clayey matter, resulting from the wholesale decomposition of the calcareous polythalamous shells. The novelty of the *Challenger* discovery consists, therefore, in the fact that clay deposits can also be assigned, like siliceous and calcareous deposits, to the resultant débris of organisms living at the surface of the sea. Supposing, therefore, that the whole globe were immersed under an entire envelope of water, deposits of all the materials of our stratified geological rocks could be going on without the slightest assistance from the degradation and wearing away of any actual land surface at all; and these deposits, subjected in the ordinary natural course of events to ordinary processes and actions, could be modified into gneiss, schists, slate, limestone, and every variety of geologic rocks.—3 *A*, *Jan.* 6, 1875, 171.

INFLUENCE OF FORESTS ON CLIMATE.

Claré, in the *Revue des Deux Mondes*, takes strong ground as to the exercise by forests of a very decided influence upon

climate. In his article he remarks that forests have a chemical, physical, physiological, and mechanical action on the climate of a country. In regard to the physical action, while the foliage of woods allows much less rain-water to reach the ground than in unwooded land, this is more than compensated by the difference of evaporation in the two cases, that of the open fields being nearly five times as great as that of the woods. The melting of snow, too, is retarded by forests, thus causing a more gradual outflow of the water. Again, forests are obstacles to atmospheric movements. An air current meeting a wood is compressed and forced upward, so that it yields part of its moisture in the form of rain. Forests also protect crops against the winds; and it is an established fact that thunder-storms are less frequent and violent in wooded regions than in open countries, as the trees draw from the atmosphere the electricity it contains, which accumulates on regions that are bare. Forests, too, have a decisive action as regards the formation of hail, hailstorms occurring but rarely in a wooded region. A case has lately been noted where a violent hailstorm on approaching and crossing a forest ceased to produce hail, but resumed its formation on passing to the unwooded country beyond.—18 *A, June* 11, 324.

NOTE ON THE VERTICAL DISTRIBUTION OF TEMPERATURE ON THE OCEAN.

Mr. Buchanan, chemist on board of the *Challenger*, writes that the effect of the changing seasons on the temperature of the sea-water seems to him not to have received sufficient attention. During the whole period of the heating of the water it has, from its increasing temperature, been steadily becoming lighter, so that the communication of heat to the water below by convection has been entirely suspended. It has, also, by evaporation, become denser than it was before at the same temperature. During the approach of winter, the superficial water having cooled, sinks through the warmer water below it, until it reaches the stratum having the same temperature as itself. Nor does it stop there, but continues to sink, owing to its density, carrying its temperature with it to the lower colder layers. The result is that we have during the winter a heating effect going on in the lower re-

gions, and during the summer a cooling effect; so that the greater the yearly range of atmospheric temperature, the greater the depth in the ocean to which its effect will be felt. He thus explains the presence of the large body of comparatively warm water in the North Atlantic, the existence of which has been usually ascribed to an assumed back-water of the Gulf Stream. This warm water is, in fact, due to no such extraneous cause, but is the actual effect of the conditions of the climate at the surface, which effects become apparent, because the water is free from the influence of oceanic currents, and exposed to the effect of climate alone.—*Proceedings of the Royal Society*, 1875, p. 123.

NAUTICAL METEOROLOGY.

Nautical meteorology has for its object the study of both atmosphere and ocean in their relations to navigation, and the utilization of our knowledge of the winds and currents, the laws of tempests, etc., in order to accomplish the shortest possible voyages between given points. The foundation of this application of scientific study to the wants of navigation was laid by Maury, and a recent work by Ploix and Caspari seems to embody many of the recent improvements that have been made. This work is intended as a guide to the mariner in the use that he can make of the charts published by meteorologists. After giving a general descriptive account of interesting phenomena, instruments, methods of observation, and the general climatological features, the volume gives a *résumé* of the oceanic routes recommended for the different months of the year throughout the navigated oceans. For instance, it insists especially upon the importance of attending to the point where the ship crosses the equator in passing from one hemisphere into the other. Thus, in order to go from Europe to either the Cape of Good Hope or to Cape Horn, we should cross the equator at the same point; but, varying with the seasons, we should pass either near the African or near the Brazilian coasts, but never in the intermediate region where the navigator is exposed to persistent calms. Another interesting point is the navigation in high southern latitudes, where we meet almost constantly west winds. Thus, in order to go to Australia, we sail from Europe to the south of the Cape of Good Hope, but in order to

return it is preferable to sail from Australia eastward past Cape Horn.—*Bulletin Hebdomadaire*, XVI., 28.

ON THE THEORY OF TORNADOES AND WATERSPOUTS.

In a general investigation into the phenomena of the cyclonic movements of the atmosphere, Cousté states that, starting from the general principle that there exists at the centre of the cyclone a column of ascending gyrating air, he deduces logically the following conclusions: First, the whole column must rotate about its geometrical axis, in the opposite direction to the gyration. Secondly, there must be a vertical oscillating movement by which the column alternately rises above and descends to the ground, carrying devastation before it. Thirdly, there must be a movement of translation, which is accomplished, as shown by observation, with a rapidity varying between twenty and seventy miles per hour. These three movements are derived from the centripetal forces developed by the gyration which give rise to lateral streams of air, which he calls radiating filaments, in opposition to those interior filaments which gyrate within the helix, and which he calls helicoidal filaments. These radiating filaments of air form a nappe which incloses the whole convex surface of the tornado, and they constitute the wall of the column, which wall, for a given state of dynamic equilibrium, is as solid as if it were a solid matter of sheet iron, for example, yet is permeable and indefinitely extensible according to the conditions of its dynamical equilibrium. These filaments are directed from below upward, following the tangent to the helix farthest from the axis, producing reactions similar to those in turbine wheels. Cousté has also determined the character of the movement along the surface of the earth; this is, in general, of a spiral nature, at least for waterspouts properly so called, which appear as truncated columns, suspended from a cloud. But for those tornadoes whose trajectory is nearly rectilinear, and for the cyclones and hurricanes whose birth takes place upon the ocean the trajectory takes the form of a parabola, whose summit is always near the side of some large continent. These remarkable peculiarities he explains by the following principles, which he has deduced from his theory: First, if the angular velocity of gyration increases or diminishes—that is to say,

if the energy of the meteor increases or diminishes—the curvature of the trajectory will rapidly increase or diminish. Second, the energy of the meteor is greater in proportion as the air which it draws in is dryer, or has a low relative humidity.

In reference to the rigidity of the column of the waterspout, Cousté says that the equilibrium between the reacting forces due to the radiating filaments exists even when the various diameters of the waterspout are made unequal by the pressure of the wind. The normal components of the movement of the wind have the effect substantially of pressing the helicoidal filaments together normally to the surface, thus concurring to maintain the rigidity of the column, to which the gyratory movement contributes. This we can easily comprehend if we compare the column to the gyroscope of Foucault; for the column of the waterspout can be likened to a series of gyroscopes having a common vertical axis, the revolving disks being formed by parallel horizontal sections of the column. In the case of the tornado the disks are gaseous, it is true, but the gas is kept in its place by the normal components of the forces; and if they have but little mass, they are, on the other hand, actuated by very rapid velocity of rotation.

Theoretically, a waterspout is a collection of parallel whirling tubular masses; a complete illustration of this is, however, very rare in nature, though such have been figured by Mouchez and others.—*Nouv. Meteorologiques*, 1875, p. 61, 81.

TREATISE ON METEOROLOGY BY MOHN.

An important treatise on meteorology has lately been published by Mohn, the distinguished chief of the Norwegian Weather Bureau. It constitutes an original German edition, with many improvements, of the work published two years ago in Norwegian, under the auspices of the Society for the Dissemination of Useful Knowledge. As was to be expected, Mohn has especially developed in this work the ideas that he has for some years defended with reference to the influence of moisture in the air upon the movements of storm areas. His whole work, in fact, corresponds to the present condition of meteorology, except, possibly, that the attempt to provide a purely popular explanation of the mechanical

laws controlling the movements of the atmosphere is somewhat unsatisfactory to the professional student.

APPLICATION OF AMSLER'S PLANIMETER TO METEOROLOGICAL CALCULATIONS.

Mr. Scott, of the Meteorological Office in London, reports that perfect success has attended the adoption of Amsler's planimeter in the calculation of the average daily temperatures. The instrument was applied directly to the photographic sheets of the self-recording instruments, and was also applied to the reduced copies of these sheets, as published in the quarterly weather reports, and the results thus obtained check each other satisfactorily.

RAINFALL AND SOLAR SPOTS.

In the monthly notices of the Meteorological Society of Mauritius, Mr. Meldrum, of that island, concludes that, whether we take the annual rainfall for the largest possible portion of the globe for short periods, or for a small portion of the globe for a longer period, we arrive at the same result: viz., an increase of rain at or near the epochs of maximum sun spots, and a decrease of rain at or near the epochs of minimum sun spots. The exceptions to this law are few and trifling, and disappear from the results as the inquiry is made to cover more extended portions of the earth's surface and a longer interval of time.—12 *A*, X., 418.

THE DRY SEASON OF BRAZIL.

As an illustration of the extreme dryness of the soil during the dry season in Brazil, it is stated that, in June, all vegetation ceases, the seeds being then ripe or nearly so. In July the leaves begin to turn yellow and fall off; in August an extent of many thousands of square leagues presents the aspect of a European winter, but without snow, the trees being completely stripped of their leaves; the plants that have grown in abundance in the wilderness drying up, and serving as a kind of hay for the sustenance of numerous heads of cattle. This is the period most favorable for the preparation of the coffee that grows upon the mountains. The beans are picked and laid on the ground, which gives forth no moisture, but on the contrary absorbs it, and being

surrounded by an atmosphere possessing the same desiccating properties, the coffee dries rapidly without becoming mouldy.—*The Empire of Brazil*, p. 23.

REPORT OF THE SIGNAL SERVICE OBSERVER ON PIKE'S PEAK.

The Signal Service observer on the summit of Pike's Peak reports that the local storms there experienced originate over the parks to the westward, on hot afternoons. On one occasion he was favored with an excellent view of the interior structure of the clouds of a tornado, when he observed that while the cloud-bearing currents of air float toward the centre they had a decided downward movement, but that masses of smoke-like vapor rapidly ascended through the interior funnel.

THE FREQUENCY OF STORMS.

Köppen has made an investigation of the frequency with which barometric minima occur in Northwestern Russia. He finds that during the years 1872 and 1873 107 cyclones occurred, lasting altogether 393 days, the mean duration of each one of these being about three and seven-tenths days. According to a table given by him, if a barometric depression is just leaving the observer, it is probable that within one or two days a second cyclone will occur. If, on the other hand, many days have elapsed since the passage of a depression, and uniform and high pressure has prevailed, then the probability that a new depression will arrive within twenty-four hours is diminished by one half.—19 *C*, VIII., 86.

THE PASSAGE OF STORMS TO EUROPE FROM AMERICA.

The great storm that passed over the coast of Germany on the 22d of November, 1873, has been investigated by Prestel, who concludes that it was identical with the storm that left the United States on the 18th day of the same month, which was at the time distinguished as a severe disturbance. In his remarks upon this subject, Mr. Prestel possibly goes too far in attempting to show that certain storms recur at certain epochs of the moon, but he is nevertheless probably nearly correct in saying that many attempts to trace lunar and other periods in the changes of the weather have, as yet, had only a negative result, because we have considered only

observations referring to a single place. It may, in fact, be stated that the currents of the atmosphere never follow precisely the same routes, nor have precisely the same effects; consequently individual places on the earth's surface are at one time within, at another time beyond, their influence, and the weather at one point shows nothing of the periodicity that may possibly regulate the movement of the current itself. Under these circumstances, the observed local readings of the barometer, temperature, rainfall, etc., can not be expected to follow any such laws of periodicity as may possibly be followed by the atmosphere as a whole. The periodicity of atmospheric phenomena can, actually, only be properly investigated when we combine the geographical details with the element of time. Following this idea, Prestel feels justified in the conclusion that certain storms which have visited the earth have passed over nearly the same paths at their successive apparitions, which latter always occur when the moon returns to about the same position with reference to the earth. As this can only happen every nineteen years, it follows that the storms of 1873 are to some extent a repetition of those of 1854.—*Zeitschrift für Meteorologie*, IX., 224.

CAUSE OF THE WARM CLIMATE OF THE WEST COAST OF NORWAY.

Professor Karsten, in an address delivered before the Society of German Scientists and Physicians, stated that the comparatively mild temperature which characterizes the west coast of Norway is not, as has been hitherto considered, the effect of the Gulf Stream, but of a warm current of water that leaves the Baltic when the cold weather sets in.—13 *A*, *November* 21, 1874, 560.

CONNECTION BETWEEN THE SEASONS AND HUMAN MORTALITY.

Messrs. Mitchell and Buchan have made a very thorough study of the influence of the seasons on human mortality, basing their investigations on thirty years of observations at London. The greatest mortality is above the average from November to April; falls to a minimum at the end of May; then rises to a maximum on the third week of July, continuing there until the second week of August, and falling thence to a secondary minimum in October. Deducting the summer

excess, which is due to one section of the population (namely, infants) and to one class of diseases (namely, bowel complaints), there remains an excess in the cold and a deficiency in the warm months, which is due to the diseases of the organs of respiration.—12 *A*, X., 210.

THE DISTRIBUTION OF THUNDER-STORMS.

Hildebrand has investigated the distribution of thunder-storms in Sweden for the year 1871, basing his study upon the observations of about two hundred and fifty stations. The number of days on which thunder was observed varied between one, two, and three in March, April, October, and November, to twenty-seven in July. Thunder-storms are found to be less frequent, not only in the cold months, but also as we proceed northwest. With regard to the daily distribution of these storms, he shows that the greatest number have occurred between 4 and 6 P.M.; the least have occurred between 10 P.M. and 6 A.M. The greater number of thunder-storms come from the northwest; whence also come the clouds and wind. Le Verrier has long since shown that in France the thunder-storms occur on the advancing side of the general atmospheric disturbances, and that they follow the movements of the cyclones; but that, on the other hand, many thunder-storms are purely local. Mohn has likewise studied the subject in Norway, and comes to conclusions quite similar to those of Le Verrier. Mohn has furthermore shown that the origin of the thunder-storm is to be found in the ascent of warm, moist currents of air. These latter, however, also develop in connection with volcanic eruptions accompanied by whirlwinds, and also when the lowest strata of air are overheated in the hottest hours of the day. He therefore classifies the thunder-storms as whirlwind thunder-storms and heat thunder-storms. The former originate on the advancing side of cyclonic storms, and follow their movements over entire countries. The latter class originate on the hot summer afternoons, and are to be considered as purely local phenomena. If, however, we combine the observations of Mohn and Le Verrier with those of Breitenlohner, it will appear difficult to make so sharp a distinction as Mohn has attempted, since both causes are acting at the same time; so that extended and regularly advancing thunder-

storms co-exist with merely local ones. The latter are, indeed, generally sporadic, and especially frequent in favorable localities, such as mountains and forests. A passing cyclonic storm is always favorable to the formation of local thunderstorms. The peculiarly favorable conditions that prevail at certain localities are shown in a very interesting way in the work of Prettner on the climate of Carinthia. — *Vierteljahres-Revue der Naturwissenschaften*, II., II., 190.

A NEW BAROMETER OF LARGE SCALE.

The great desirability of being able to observe the slightest changes in atmospheric pressure has led to the production of many more or less unsatisfactory barometers, of which in general it may be remarked that, although they do really afford us a highly magnified scale of movement, yet the moving parts are themselves so weighty that the sluggish behavior of the instrument entirely neutralizes the advantage which was sought, so that the slight momentary changes in atmospheric pressure still pass by unperceived. To meet these difficulties, Mr. Hirn, one of the most eminent French philosophers, has described an instrument which he calls the Megabarometer: his apparatus consists of three vertical glass tubes, closed at their ends, and connecting with a horizontal tube by means of iron sockets. The middle tube, filled with mercury up to half an inch of its top, is a true barometer. Its neighboring tube on the one side has about four millimeters' internal diameter, while the other tube has one millimeter diameter, but is soldered at its top to a closed bulb of about four centimeters' internal diameter. The lower half of this bulb is filled with mercury, the upper half with alcohol. The first of the three tubes thus constitutes a barometer composed of two liquids, and the variation of level in the two open tubes on the right and the left hand is very nearly in an inverse ratio to the densities of the liquids; so that a change of one inch in the height of the mercury brings about a change of seventeen inches in the alcohol tube.—*Nouvelles Meteorologiques*, p. 34.

MIRAGE.

In some remarks on the phenomena of mirage, Professor Everett states that when a ray of light is passed through a

portion of air which is not equally dense on all sides of the ray, it is deflected toward the side on which the density is greatest, the sharpness of the curvature being proportional to the rates at which the density varies. If the air is stratified horizontally, it follows that a ray traveling nearly horizontally will be bent the most, and it is by such rays that we see the images which constitute mirage. In the average state of the atmosphere the curvature of horizontal rays is about one fifth or one sixth of the curvature of the earth's surface, being greater in cold than in warm weather, and greater with high than with low barometer. The curvature, however, depends principally upon the rate at which the temperature changes with the height. The average rate is one degree for 300 feet. If the rate were one degree for fifty-three feet, the horizontal rays of light would be straight lines. A more rapid rate than this will render the air above denser than that below, and cause rays to bend up instead of down. This condition of affairs may exist for a time, although it is a condition of unstable equilibrium, and must eventually be broken up by the inflow from the surrounding regions of cold air. An increase of temperature upward at the rate of about one degree in sixteen feet will make the curvature of horizontal rays equal to that of the earth, so that they may encircle the globe. Any such downward bending of rays of light increases the range of our vision, enabling us to see around the horizon, which otherwise limits the view, thus bringing distant objects in sight, and rendering nearer objects more distinctly visible, but without in any way inverting them.—12 *A*, XI., 151.

THE NEW SELF-RECORDING BAROMETER.

A self-recording barometer has recently been made by Mr. Redier, which seems to have many excellent points, and to be enthusiastically received in France. In a communication to the Meteorological Society of Paris, he states that his instrument consists of an ordinary syphon barometer carrying a very light ivory float, upon which is fixed a vertical steel wire terminating in a point. A horizontal needle rests upon this point, its other extremity is in connection with a double series of clock-work, the wheels of which move either forward

or backward, according as the ivory float rises or falls. The movements of the clock-work are followed by a pencil which draws a curve upon a revolving cylinder. In a very similar instrument devised by Professor G. W. Hough, of Albany, and highly prized by American meteorologists, the connection between the horizontal lever and the wheel-work is an electric one, and subject therefore to all the uncertainties of the electrical batteries and connections. In Redier's barometer no electricity is employed, the entire apparatus depending only upon gravity and atmospheric pressure, and its working is evidently perfectly regular and reliable. An aneroid barometer may be made to record its indications in the same manner as the mercurial, and such instruments have, we understand, already been constructed under Mr. Redier's directions. Mr. Silberman has suggested a method by which a similar automatic system of registration could be applied to the indications of the magnetic needle.—*Nouvelles Meteorologiques*, 1875, p. 16.

CURRENTS OF AIR WITHIN CYCLONES AND WATERSPOUTS.

In a memoir on cyclones and waterspouts, Mouchez publishes some observations made by him while upon the ocean, and which, if correct, are quite important. According to him, at or near the surface of the ground the movement of air in the cyclone is always from below upward, while in whirlwinds the movement is, on the contrary, from above downward. In the former case the winds are winds of aspiration; in the latter case the wind descends from the cloud in the form of a bag or tube, which terminates in a point. He believes that waterspouts have no relation whatever to cyclones, having an opposite appearance and cause. In this opinion Renou also concurs.—*Nouvelles Meteorologiques*, 1874.

THE PROGRESSIVE MOVEMENT OF AREAS OF COLD AIR.

Dove has attempted to deduce, from the five-day means of temperature for European stations, some general views as to the progress of days of remarkable cold, and finds that in the months of January and February of the years 1855, 1856, 1870, and 1871, numerous cases occurred to show, almost uniformly, that the "cold terms" move westward over Europe;

a result that may, perhaps, be considered as entirely in agreement with the deductions of Buchan, based upon the barometric charts prepared by him.—*Monatsbericht Berlin Acad., Feb.*, 1874, 118.

A VERY DELICATE BAROMETER.

An ingenious device has been constructed by Mendelef, which shows the slightest variations of pressure by means of a small U-shaped tube containing petroleum oil. One end of this tube is closed, and contains a certain volume of dry air maintained at a constant temperature, while the other end is open to the air. The instrument being accurately adjusted by means of a mercurial plunger connected with the bottom of the U-shaped tube, so that the petroleum is exactly on a level in the two branches of the tube, it is found to be so extremely sensitive that the slightest variation of atmospheric pressure is shown by the alteration of the level, and the amount of this alteration can be measured with the greatest precision.—12 *A*, XI., 55.

THE PENETRATION OF COLD INTO THE EARTH.

From observations on the temperature of the surface of the earth which have been made regularly at the Botanical Gardens at Paris, by the Messrs. Becquerel, by means of the electric thermometer invented by them, some interesting conclusions have been deduced. Their observations have been extended to the depth of one hundred and seventeen feet; but most attention has been paid to that portion of the earth nearer the surface. With reference to the penetration of cold into soils of similar character, but one of which is bare and the other covered with grass, while both are covered with snow, the observations have shown that when the temperature of the air sinks from zero to $-12°$ Centigrade, the temperature of the earth at the depth of twenty inches never sank to zero under the grass-covered earth, while it sank at the same depth to $-5°$ under the bare surface. From these observations Becquerel makes the practical suggestion that if in a sandy soil we desire to cultivate plants whose roots suffer from frost, we must cover the soil with grass-sod; and, for similar reasons, if we desire to preserve vegetables or other products during the winter under the soil, and secure

them from frost, we should in this case also cover the soil with grass.—19 *C*, XIV., 135.

AQUEOUS VAPOR IN THE ATMOSPHERE.

The *Academy* sums up the conclusions of Dr. Hildebrandson, of Upsala, in regard to aqueous vapor in the atmosphere, as follows: 1. The permanent gases in the atmosphere do not form independent atmospheres, but have effected a complete mutual interpenetration; as all experiments show that the constitution of the air is the same at all heights. 2. The incessant evaporation and condensation which are in progress render impossible the existence of an independent vapor atmosphere, or of a homogeneous mixture of the vapor with the permanent gases, and must cause the vapor to diminish rapidly with height. 3. It is not allowable to subtract the vapor pressure from the barometer reading to obtain the pressure of dry air.—13 *A*, *Feb.* 6, 1875, 145.

THE NEW ANEMOSCOPE.

Michelle describes an ingenious anemoscope in which three arrows are used, of which the upper one indicates the direction of the wind at each moment. The second indicates the extreme wind on the right, and the third indicates the extreme wind on the left hand. Thus, when one looks at the wind vane, we see not only the wind that now prevails, but the extreme winds on either side that have prevailed since the preceding observation.—*Bulletin Hebdomadaire*, XVI., 12.

PERIODICITY OF RAINFALL.

Governor Rawson, of the island of Barbadoes, whose remarkable studies upon the rainfall of that island have been already noticed, states that it is an error to suppose, as Mr. Meldrum does, that the observed rainfall in Barbadoes in any way really supports Mr. Meldrum's theory that there is a sun-spot period in these meteorological phenomena. He, however, very philosophically adds that, if the conclusions drawn from a wide area and very long periods of observation do support that theory, then the opposite results obtained in Barbadoes, although that island is most favorably situated for these observations, only show that no particular

locality can draw a safe inference as to the manner in which the presence or absence of sun spots is likely to affect it.

But looking more deeply into the matter, Governor Rawson very justly adds that if there has been more rain in certain quarters of the globe in certain years, there must have been in other quarters during those same years greater evaporation, whence it results that the same solar phenomena produce in one portion of the world opposite effects to those produced elsewhere.—12 *A*, X., 264.

MARITIME CONFERENCE IN LONDON.

At the recent Maritime Conference in London the resolutions adopted by the meeting embraced the following subjects. It was resolved that there should be but one form of meteorological register for naval and merchant services, and that so far as possible a uniformity in methods and hours should be observed. Ocean currents and magnetic variations were recommended for observation. The upper and lower clouds are to be recorded in separate columns. The precise patterns of instruments were not specified, the only requirement being that those used should satisfy certain tests, and that they should be carefully compared with standard instruments. It is considered that the general influence of the Conference was decidedly in favor of united action on the part of the merchant service and the navies of the world. Particular stress was not laid upon the conducting of special investigations by sea-captains, as such can be most economically performed at the central meteorological stations and by government naval vessels.—12 *A*, X., 431.

THE TEMPERATURE OF STORMY WINDS.

Dr. Fritsch, of Vienna, communicates to the *Annual* of the Vienna Meteorological Institute some observations on the temperature of the storm-winds at Salzburg. He states that, since 1864, he has every summer resided in Salzburg without noticing the high temperatures of the southeast storm-winds; but that since he has resided there constantly during the past few years, this has been forcibly brought to his attention, as also the great dryness which accompanies these winds. From the records made at 7 A.M., and 2 and 9 P.M., from 1863 to 1869, he has selected the stormy winds, and

finds that both the southeast and northwest storms experienced at that place are much modified by the influence of the Alps. The southeast, or föhn, wind has, at all seasons and at all points, a notably high temperature, the exception only being in the three summer months, in which the föhn decidedly depresses the temperature. In the winter and summer the temperatures of the southeast and northwest storms are nearly the same, but in the spring and fall the southeast are decidedly warmer than the northwest storms. In the high southeast winds the air is clear and dry, but in the northwest cloudy and moist.

ON ATMOSPHERIC PRESSURE, WINDS AND RAIN.

A recent supplementary volume of Dr. Petermann's geographical notes gives us a comprehensive memoir on our present knowledge of the atmospheric circulation by Dr. A. Wojeikof, which is accompanied with highly interesting and valuable charts; the last of the charts gives us a new view of the distribution of rain over the earth, in that it distinguishes between the areas of summer and winter rains, besides giving us the results of the most recent investigations as to the general distribution of the rain-belts of the earth. In general, Dr. Wojeikof finds that between the poles and 40° of latitude the rainfall is liable to occur at all seasons of the year, the variations being seasonal in their nature. Thus Siberia and British America receive most of their rains in the summer time; Great Britain, Norway, France, and Portugal receive their rains in the fall. Between these polar regions and the rainless zone of the trade-winds Wojeikof introduces belts of sub-tropical rains, which are, he thinks, essentially oceanic, while the polar rain-belts are essentially continental. In considering the distribution of rain in Siberia, he states a law which, verified by independent observations, is a remarkable confirmation of a theoretical deduction due to Mr. Ferrell. According to Dr. Wojeikof, the atmospheric pressure in winter in the higher latitudes is lower over those seas that have no connected ice-fields. According to Mr. Ferrell, the pressure in the polar regions of the earth is lower in proportion as we diminish the frictional and other resistances offered by the earth to the movement of the air. If, therefore, the resistance offered by fields of ice is sensibly greater than

those offered by the open sea, or small ice-floes, then Professor Ferrell's proposition explains at once Dr. Wojeikof's generalization.—*Petermann's Mittheil.*, *Ergänzungsh.*, No. 38.

THE IMPORTANCE OF METEOROLOGY.

The annual report of the Radcliffe Observatory, delivered at Oxford, June 29, states that the principal labors at that institution continue, as formerly, to be given to the transit circle and the heliometer, and that the meteorological observations made at that observatory are reduced much more elaborately than is done at the greater number of astronomical observatories, and are presented to the public in the most scientific shape that they admit of. "I am also of the opinion that they are worthy of the labor which is bestowed upon them, and I differ in opinion from some eminent authors as to the rank which meteorology already occupies among the physical sciences. At all events, I think a similar system of reduction should be employed at other observatories."

SECULAR CHANGES OF CLIMATE.

"The Indications of Spring" is the title of a work communicated to the Royal Society, in 1789, by Mr. Robert Marsham. These indications were based upon observations, commencing in the year 1736, by Robert Marsham, and which were continued until 1812 by his descendants of the same name. The record was again begun in 1836, and continued until the present time by the Rev. H. P. Marsham. This record of one hundred and forty years which we owe to the Marsham family has preserved innumerable notes in reference to botanical and other natural-history phenomena, and, for a greater portion of the time, the record was very full and careful, the first Mr. Marsham being an observant naturalist, and exceedingly fond of rural pursuits. An analysis of these observations has recently been presented by Thomas Southwell to the Naturalist Society of Norfolk and Norwich, who states that, as it has often been stated that "our old-fashioned winters have departed," and that the springs have become later, he has sought to test the question by taking the average days of the occurrence of twenty-five different phenomena indicative of the seasons during the years 1763 to 1774 inclusive. He did the same with the ten years ending

1874, and finds that the average date corresponding to the whole twenty-five phenomena is, for the eighteenth century, April 7, and for the nineteenth century March 28, showing that the springs are now nine days earlier than they were one hundred years ago. These dates are based respectively upon 196 and 181 observations; and it is not probable that the difference is owing to any fault of observing, but it is possibly due to drainage or cultivation. The extreme variability even of the English climate is illustrated by the range in the dates of certain phenomena. Thus, turnips are reported in flower December 25, 1846, and May 14, 1784. The wood-anemone was observed in flower March 9, 1775, and April 30, 1837. The average range of phenomena noted by Mr. Marsham is about seventy days.—*Transactions of the Norfolk and Norwich Naturalist Society*, 1875, 46.

METEOROLOGY IN NEW SOUTH WALES.

The private observatory of Mr. John Tebbutt, of Windsor, New South Wales, contributes to the meteorology of that part of the world a volume of observations made from 1867 to 1870, which observations have been recorded regularly at 9 A.M., and are supplemented by the records of self-registering maximum and minimum thermometers. The geographical position of the observatory has been determined by an extended series of observations of moon-culminating stars for longitude, and by observations in the prime vertical for latitude. The observatory is also connected by telegraph with the Sydney Observatory, which has, until recently, been under the directorship of Rev. W. Scott. The observatory of Mr. Tebbutt is situated on a hill near the centre of the peninsula at the eastern extremity of the town of Windsor. It is about 28 miles from the sea-coast on the east, and about 8 miles from the Blue Mountains on the west, and is surrounded by the forest except in its immediate neighborhood, where the soil has been cleared and cultivated for more than fifty years. Many of the meteorological instruments used in these observations were made in Sydney; others were brought from England, where they had been carefully compared with accepted standards. From the tables given in this volume of observations, it appears that the total amount of rain, as measured at Windsor, has been, in 1867, 44 inches;

in 1868, 27 inches; in 1869, 32.6 inches; in 1870, 62.5 inches. The evaporation from a basin of water, stationed seven feet above ground, amounted, in 1867, to 82.5 inches; in 1868, to 75.6 inches; in 1869, to 75.9 inches; and in 1870, to 60 inches. But the evaporation from a similar basin placed on the ground is about one half of these amounts. The highest average barometric pressures occur in April, May, June, and July, and the lowest average pressures occur in December and January. The highest temperature of the air recorded by the thermometer shaded from the direct rays of the sun occur in December and January, and reached, in 1867, 113°; in 1868, 113.6°; in 1869, 108°; and in 1870, 112.5°. The lowest temperatures recorded by the minimum thermometers shaded from the influence of radiation at night occur in July and August, and were, in 1867, 29.7°; in 1868, 24.8°; in 1869, 29.5; and in 1870, 29.6°.—*Meteorolog. Observations by John Tebbutt, Sydney*, 1874.

CARBONIC-ACID GAS IN THE AIR.

According to experiments that have been made by many chemists since the discovery of carbonic-acid gas, a larger per cent. of this substance is found in the atmosphere in the summer than in the winter, in the proportion of 71 to 48. Boussingault found that, out of ten thousand volumes of air, $3\frac{9}{10}$ were carbonic-acid gas during the day, and $4\frac{2}{10}$ during the night. Peligot having calculated the quantity of carbonic-acid gas that must result from the burning of oil and coal, from various industrial operations as well as natural phenomena, shows that there must be a large compensation, such that the gas produced by one class of operations is decomposed by another; so that it happens that the proportion of the gas in the atmosphere remains nearly constant, at least at the surface of the ground. The recent balloon ascensions in France have undertaken to determine the rate at which the quantity of gas varies with our ascent in the air. According to the experiments that had previously been made upon mountains, the proportion of gas diminishes slightly with the ascent in the air; but balloon ascensions have the special advantage that the observer is, by the balloon, carried far above the influence of the soil. The results of the first of the recent voyages in the "Zenith" gave, for carbonic-acid

gas at 800 meters' altitude, 24 parts out of 100,000; and at 1000 meters, 30 parts out of 100,000. The difference between the two figures is the limit of the errors of observation.—13 *B.*, III., 333.

EARTHQUAKE IN THE VICINITY OF NEW YORK, DECEMBER 10, 1874.

On the 10th of December, 1874, an earthquake was felt in the neighborhood of New York, especially near Yonkers. It has formed the subject of study by the New York Lyceum of Natural History. From a report made to the Lyceum by Professor D. S. Martin, it appears that exact observations could not be obtained sufficient to give a definite basis for any physical investigation; showing, we may remark, forcibly, as is shown in a thousand other ways, the importance of having a uniform standard time, which shall replace the innumerable erroneous local times adopted in every portion of our country. Had each of Professor Martin's observers possessed a time-keeper set to correct time, he would have been able to add much of interest to our knowledge of the nature of this earthquake. In general, he states that the shock was felt from near Fishkill, southward, eighty miles, to Sandy Hook, and in an east and west direction from Morristown, New Jersey, eastward, sixty miles, to Stamford, Connecticut. The movement was felt far more strongly and frequently on rocky than on soft ground. In the main, the shocks seem to have been limited by the Highlands of New York and New Jersey. In only one case was the shock reported as felt on the water, which was by a schooner in the harbor of New Rochelle.

VOLCANOES IN ICELAND AND ASH-SHOWERS IN NORWAY.

A series of interesting volcanic phenomena has been, for some time past, in progress in Iceland, outbreaks having occurred from January to April. The eruption was steadily spreading over the wilderness, and so large a district of the surrounding country has been covered with ashes that the farmers have been obliged to remove, in order to find pasture for their stock. The eruption from the principal crater takes place through a fissure, from which the molten red-hot lava is thrown two or three hundred feet into the air, in one

compact column. At times, twenty or thirty of these columns can be counted. A bluish steam accompanies the eruption, which rises straight into the air with great power, from many hundreds of fathoms.

In connection with this eruption, it is interesting to notice that during the nights of March 29 and 30 a heavy rain of ashes or sand took place along the west coast of Norway to the Swedish frontier, the whole country being covered with gray dust to such an extent that from a pint of snow more than a tablespoonful of residue was left after the snow had melted. The dust consisted of little irregular sharp-edged grains, principally silicates, and probably originated from the eruption in Iceland.—12 *A*, XII., 75, and XI., 575.

DRYNESS OF THE SOIL IN INDIA.

In a memoir on the waterworks at Nagpur, Central India, Mr. Binnie gives a large amount of information with reference to the variability of the rainfall in India and other countries; and among the investigations into which he entered was one illustrating the dryness of the soil during the dry seasons, and the consequent amount of water absorbed by it after every rainfall. An area of $6\frac{6}{10}$ square miles, or 4224 acres, was drained by trenches into a reservoir, and the height of water in the latter subjected to careful observation. Three rain-gauges were also placed within this area, by means of which the rainfall could be determined. It was found that in the case of a measured fall of 2.24 inches of rain which fell in one hour and twenty minutes on the 18th of June, there was no perceptible drainage from this area into the reservoir, while on the 16th of September, in the case of a rain of 2.2 inches, which also fell in one hour and twenty minutes, the drainage into the reservoir amounted to over 33,000,000 cubic feet. These opposite results prove the extreme state of dryness of the soil in India at the end of the heated season, and its complete saturation after the heavy rains of the monsoon period. Of the drainage observed on the 16th of September, 98 per cent. entered the reservoir within two hours and fifty minutes. As to the question what percentage of total annual rainfall drains from the ground and can be emptied into reservoirs, Binnie states that almost every drainage area has, in this respect,

peculiarities of its own. Thus the average annual rainfall at Nagpur is 40.7 inches, of which 37.5 fall in the monsoon, and 3.2 in the dry season. Of this latter quantity, no part flows from the ground into the reservoir; and the records of the discharge of the drainage area are confined to about four months. The total depth evaporated during this time amounted to about four feet, or an average of about one fifth of an inch per day. The total loss of water during the season from the reservoir from all causes amounted to 104,000,000 cubic feet, out of which 55,800,000 cubic feet was evaporated, leaving 48,200,000 cubic feet as used or absorbed. An extensive comparison is given by the author between solar spots and India rainfall; but no very satisfactory conclusions are drawn by him.—*Minutes of the Institution of Civil Engineers*, XXXIX., Part I., 16.

MAGNETIC DISTURBANCES AND AURORAS IN THE ARCTIC REGIONS.

Lieutenant Weyprecht reports that the magnetic disturbances in that portion of the arctic regions visited by the Austro-Hungarian North Polar Expedition are of extraordinary frequency and magnitude, and are closely connected with the aurora borealis; the disturbance being the greater and quicker the more convulsive the motion of the rays of the aurora and the more intense the prismatic colors. Quiet and regular arcs, without motion of light or radiation, exercised almost no influence upon the needles. In all disturbances the declination needle moved toward the east, and the horizontal intensity decreased, while the inclination increased. Movements in an opposite sense, which were very rare, can only be looked upon as movements of reaction. Weyprecht had expected to be able to connect the aurora with the galvanic earth current; but being far distant from the land, he was obliged to bury his connecting plates in the ice, in consequence of which the movements were too feeble to be observed. A similar failure attended the attempt to observe the atmospheric electricity. He found that storms followed almost every time after intense auroras, and thinks he is justified in the conclusion that the aurora is an atmospheric phenomenon, and closely connected with meteorological conditions.—12 *A*, XI., 368, 397.

A NEW SEISMOMETER.

A seismometer devised by Malvosia, of Bologna, is thus described: On a slightly inclined board is fixed a spherical cap, having eight grooves corresponding to the eight principal points of the compass. A little beyond the edge of the cap there is a projecting wooden ring which limits the inclined surface. On the top of the cap is poised a little brass ball slightly flattened at the point of contact. Upon the ball rests very lightly a conical weight, by a small screw projecting from its base; which weight is suspended by a chain from an overhanging arm, movable up and down on a support at the side. The least shock will make the ball topple over. When it does so, it runs down one of the grooves of the cap to the inclined plane, at the lower part of which it finds a hole, and, passing into it, causes a gun to be fired off. After the ball leaves its position on the cap, a spring needle, longer than the diameter of the ball, shoots out from the little conical weight that rested on the ball, and catches in that groove of the cap down which the ball has run. Thus the direction is indicated from which the shock came. The instrument can be made very sensitive. It differs from that recently introduced by La Saulx into the earthquake stations of Prussia, principally in that the apparatus does not of itself record the exact time at which the shock took place, but merely calls the attention of the observer by means of the discharged gun. By combining the instrument of La Saulx with the simple upright pillar seismometer as described by Mallet, observations could be obtained which would be of more value than those given by the seismometer of Malvosia.—*Journal of the Franklin Institute*, *April*, 1875, 243.

THE MAGNETIC DECLINATION AT ST. PETERSBURG.

The long series of observations of magnetic declination that has been accumulating at St. Petersburg during the last 150 years has been subjected to a very full study by Mielberg, of that city, who has taken especial pains to examine the accuracy, reliability, and even genuineness of the observations, and to correct them for such sources of error as can be appreciated. The independent observations made

by Nervander at Helsingfors, from 1844 to 1848, afforded him an excellent point of comparison, and the means of determining the diurnal period of the declination. The annual variations could then be investigated, and finally the secular. From twenty-two years of observations, between 1841 and 1862, he has thus been able to compile a table representing the normal hourly variations of declination for each month, and for the entire year; from which it appears that the greatest western declination occurs between one and two o'clock A.M. in every month, being a little earlier in summer and a little later in winter, with a secondary maximum just before two o'clock, and closely following the principal maximum. The greatest easterly declination occurs in the winter months between nine and ten A.M. During the rest of the year it varies between seven and nine A.M. The other maximum of easterly declination is not so decidedly expressed, and occurs in winter and spring between ten and eleven A.M. In respect to the secular variations of the declination, it would appear to have varied between two and a half degrees west in 1727, to six and a half degrees west in 1831, reaching its maximum about the year 1806, when it was about nine and a half degrees west. He suggests that if the increasing accuracy in our means of measurement is to have any meaning at all, and not be a useless expenditure of time and money, it becomes necessary now that, in any place where a magnetic observatory is surrounded by an assemblage of houses, there should be annually made, for purposes of comparison, an independent standard determination of the declination at some point near by but entirely outside of the buildings in question, and free from their influence.—*Wild's Repertorium*, IV., art. 1.

ATMOSPHERIC ELECTRICITY.

In reference to atmospheric electricity, Sir William Thomson states that if one ascend any mountain peak on a fine day, and there prove that the surface of the earth on the peak is negatively electrified, the result will be valuable to science; and if on several days the ground is found to be, all day and all night, negatively electrified, then there will be a very great acquisition to our knowledge regarding atmospheric electricity. According to him, positive atmos-

pheric electrification of the air is merely inferential. What we know by direct observation is simply that the surface of the earth is negatively electrified; and many misleading and delusive statements in reference to the positive electricity of the air are to be found in encyclopædias and treatises on meteorology. Suppose, for a moment, that there were no electricity whatever in the air; that it was absolutely devoid of all electric manifestation, and that a charge of electricity were given to the whole earth—for which purpose no great amount would be necessary—such amounts as we deal with in our great submarine cables would, if given to the earth as a whole, produce a very considerable electrification of its surface. And suppose, in addition, which in fact seems to be shown by experiment, that all space above the atmosphere, and that the atmosphere itself were a non-conductor; then the charge could be given to the earth as a whole, just as a charge could be given to a pith ball electrified in the air of the room. Under these circumstances, all the phenomena that have thus far been brought to light by atmospheric electrometers would be observed just as they are. The ordinary observation of atmospheric electricity would give just the result that has been obtained from it. The results that we obtain every clear day in ordinary observations on atmospheric electricity are precisely the same as if the earth were negatively electrified, and the air had no electricity in it whatever. Ordinarily we have evidence in the lower strata of the air of the presence of negative electricity; but in rainy weather it is sometimes positive and sometimes negative.—*Journal of the Society of Telegraph Engineers*, 1874, III., 12.

THE DESTRUCTIVE FLOODS IN SOUTHERN FRANCE.

The terrible floods which swept over several hundred miles of the northern portion of the Pyrenees and the plains at their base, appear, in the light of later and more reliable accounts, to have been far more destructive to life and property than was indicated by earlier reports. The Garonne and its affluents, which drain the larger portion of the Pyrenees, seem to have risen with such rapidity that at Toulouse, as an instance, a low-lying suburb, St. Cyprien, chiefly inhabited by the working classes, was overwhelmed almost

without warning, many people being drowned in the ruins or crushed by falling buildings, and scarcely any property being saved. Another suburb shared a similar fate, but the inhabitants were fortunately able to escape with their lives. All along the course of the main river and its tributaries towns and villages were destroyed, some with hardly a vestige remaining, and the dead were numbered by thousands.

These destructive outbreaks have of late become periodical at Toulouse, but none have ever left such desolation behind as this one. Now for the moral of this pitiable story, and for the sake of which we have reproduced it. One cause of this terrible calamity, it is very generally conceded, is to be sought for in the wholesale destruction of the forests of the surrounding country, which has been going on for years. Our contemporary *Iron* puts the case concisely in the following terms:

The cause of this calamity is, no doubt, the three weeks' previous heavy and continuous rains, which fell over the whole range of the Pyrenees; the drainage of this rainfall having been accelerated by the stripping of the mountains and upland tracts of their natural clothing. We have on several occasions pointed out the way in which this excessive and unwise destruction of natural wood, among other and serious climatic evils, aggravates the effects of the rains which usually fall at the equinoctial periods, but are not confined to them. In the present case it appears that there has been a widespread destruction of timber in the district during the century, and thus the exceptional downfall, neither intercepted by the loosened earth and undergrowth, nor absorbed by vegetation, scarcely penetrates beneath the surface, but runs off as it falls, spreading desolation now, and occasioning drought later in the year. The latest estimate of the loss by these floods is 2000 lives in Toulouse alone, and about $75,000,000 worth of property. Twenty thousand persons likewise are estimated to have been rendered homeless and destitute, besides being deprived of the means of earning their bread.

CHANGES IN THE LEVEL OF THE WATERS OF LAKE GENEVA.

Professor Plantamour, of Geneva, has subjected to examination the observations made since 1838 on the heights of

the water of Lake Geneva. These observations have been systematically and carefully made for forty years, and in all cases the bench marks to which the levels of the water are referred are points so well known that the entire series of observations can be considered as perfectly comparable among themselves, except in so far as a slight uncertainty attaches to a portion of the observations, due to an accident which occurred to the recording apparatus. After carefully correcting and reducing the whole series of observations to a uniform standard, it appears that the annual variation in the height of the lake is distinctly pronounced for each year of observation, but that the water returns to the same level at the same epoch of each year. The lake appears to have been lowest in December, 1857, and to have been highest in July, 1846; the entire range between these figures being only seven feet. It is, on the average, lowest on the 11th of February, and highest on the 7th of August. The connection between the accidental or extraordinary variations in the level of the lake, and the meteorological conditions, especially rain and melting snow, is fully examined; and it appears that the heat of the autumn is a very important factor in determining the volume of the waters of the Rhone, and consequently that of the lake. By means of a table giving the quantity of rainfall, and the temperature of the spring for each year as compared with the averages, Plantamour is able to explain away so large a portion of the irregular annual variations of height of the water that the remaining discordances are remarkably small; while there are groups of positive discordances, which have suggested the propriety of comparing the heights of the lake, year by year, with each other, in order to deduce the secular variations, if any exist. He has, therefore, divided his series into periods of nine years each, from which grouping it is shown that the level of the maximum water has not varied in any progressive manner in the course of thirty-six years, and that the annual fluctuations depend upon the dryness or wetness, the cold and the warmth of the year. If, however, within each of these groups, we compare the levels of the water, we find that the heights at low water are larger in proportion as the rainfall diminishes, and a gradual increase in the level of low water is noted, which can not be explained by

atmospheric circumstances. These changes, it is suggested, are probably due to the modifications that have taken place in the course of years in the hydraulic works, and the drainage of the neighborhood. There seems to be no trace of such a change as Mr. Dawson states that he has found in the levels of the Great Lakes of North America, according to whom these vary in a period of about eleven years, following closely the changes in the solar spots.—*Mem. Soc. Phys. Geneva*, 1874.

THE ELECTRICAL CONDITION OF SPRING WATER.

Messrs. Theury and Minnich state that they have employed a delicate galvanometer in making some experiments on the electricity of the warm springs in Baden and Switzerland. One of the platinum electrodes was plunged into the upper spring at Stadthof, and the other electrode into the little stream Limbat. As soon as the metallic connection was completed, the needle of the galvanometer moved violently, oscillating about 74°; then in proportion as the electrode was covered with bubbles of gas, and became polarized, the galvanometer needle descended to 72°, and even to 60°, ascending to 70° when the electrode was cleansed of bubbles with a brush. This experiment shows that the thermal water was very strongly electrized, the source of the water being negative. Again, placing two vases of water side by side, the first vase filled with spring water, taken immediately from the source and still quite warm, the second vase filled with cold water from the river, the platinum electrodes were introduced, and immediately the needle of the galvanometer indicated a current flowing from the cold to the warm vase; that is, in the same direction as the current of the spring, the warm spring water being electrized negatively. When the spring water had completely cooled, it was again heated with an alcohol lamp to a temperature of 47°, and the electrode immersed, but without observing any appreciable current in the galvanometer.—1 *B*, XV., 411.

ON THE SECULAR DIMINUTION IN EUROPE OF SPRINGS, RIVERS, AND STREAMS, WITH THE SIMULTANEOUS INCREASE IN THE FLOOD WATERS IN CULTIVATED LANDS.

A memoir by Gustave Wex, published at Vienna in 1873, on the diminution of water in springs and rivers, and the in-

crease in the flood waters in cultivated lands, has lately been the subject of a report by the Vienna Academy of Science, from which it would appear that the diminution experienced in the course of the last few centuries in the average height of the water (especially the low waters) of the Rhine, the Elbe, and other rivers of Europe, is to be attributed to a diminution in the annual quantity of water available for the rivers, and taking account of the amount of evaporation, there still results a diminution in the amount of water supplied by springs and rainfalls. It appears to the commission probable that the influence of forests is perceptible on the annual rainfall, and especially on the distribution of the rain throughout the year, although direct observations do not yet suffice to determine the magnitude of this influence. Among the causes tending to this diminution of the water in the rivers, the commission enumerate, first, the extinction of the forests, which exerted a beneficial influence in maintaining and elevating humidity, in diminishing the extremes of temperature, and diminishing the evaporation, and in assisting to a more equable drainage of the precipitation. A second cause is found in the drying up of the lakes, ditches, and morasses, which also would have exerted an influence similar to that of the forests. Third, in the cultivation of extended areas of land, which cultivation demands the consumption of considerable quantities of water. Fourth, in the increase of population, although the effect of such increase can directly account for only a slight percentage of the entire diminution. Finally, the commission consider the suggestion of Sàlmann as worthy of consideration, according to whom water is being employed in the interior of the earth in the formation of minerals which contain that liquid in chemical combination. In view of these considerations, the commission recommend that the Austrian government institute such observations as will lead to a further knowledge on this subject, and especially take such steps as will prevent the further diminution of water from becoming a calamity to future generations. Efforts will also be made to collect more complete data from the inhabited portions of the world; and especially is the hope expressed that the Viceroy of Egypt may cause tables and graphic representations to be made of the observations on the height of the water at the Nilometer at Cairo, where

such observations have been regularly made for the past 3000 years.

The actual diminution in the annual average height of the water, as deduced by Wex, is, for the different parts of the Rhine, from 6 to 60 inches during fifty years; for the Elbe, at Magdeburg, 17 inches; for the Oder, 17 inches; and for the Donau from 18 to 55 inches. — *Sitzungsbericht der Akademie der Wissensch., Vienna,* LXIX., *April* 23, 1874.

PHOTOGRAPHING THE WAVES.

The various mathematical theories that have been, thus far, elaborated with reference to the movements of vessels upon the waves are only approximate. It is only by experience that we are able to determine to what degree of exactness these theories have arrived, and in order to verify them it is necessary to register the successive inclinations that a wave gives to a vessel. The photograph allows us to obtain the law of these inclinations. Let us suppose that a photographic apparatus, having its axis perpendicular to the diametral plane, be directed toward some point in the horizon. We should obtain on the sensitive plate an image of the sea and of the heavens, separated by a horizontal line, which would be the image of the horizon. Let us mark upon the plate the position of this image when the axis of the apparatus is upright. If it is then inclined by an angle, i, about a horizontal axis parallel to the diametral plane, the image of the horizon will remain parallel to the primitive line, but be displaced by a quantity equal to f, tang. i; f being the focal distance of the objective. Let us suppose now that we place before the sensitive plate a fixed shutter pierced with a vertical slip; the image will be intercepted, except in that part of the plate situated behind the slip. We shall thus have upon the plate a broad band of two different tints corresponding to the sky and the sea, divided by a segment of the horizontal line. Consequently, if we take an instantaneous photograph at the moment when the ship is inclined at the angle i, we shall have a segment of the horizon line, and the distance of this line from the primitive horizontal line will give the angle i. In order to realize these conditions, it suffices to make the sensitive plate move horizontally with a uniform movement. If, during this movement, the

vessel remains vertical, the segment of the image of the horizontal line will continue at a constant height upon the plate. Consequently it would trace upon the plate a horizontal line. Let us suppose now that the ship rolls; at each instant there would be a certain inclination, *i*, and at this moment a certain zone of the plate will be found behind the opening of the shutter. The image of the horizon will traverse this window at some point of this zone, and it will fall upon the plate at a distance from the reference line equal to *f*, tang. *i*. Experiments have been authorized according to this method, which is the invention of Huet, at Brest, and the photograph proofs show the good results that were obtained.

BAROMETRIC OBSERVATIONS ON THE OCEAN.

Dr. Buys Ballot communicates in a preliminary way the results of the great unpublished work undertaken by the Meteorological Institute of the Netherlands, and which consists in the derivation from over three hundred thousand observations on board vessels of the average barometric pressure for each month, and for every five degrees square throughout the navigated portions of the North and South Atlantic Oceans. The average barometric pressure within ten degrees of the equator is 760.04 millimeters. The pressure within ten degrees of the parallel of 30° north is 765 millimeters; and within ten degrees of the parallel of 30° south it is 762.5. Beyond these latter parallels the pressure diminishes steadily toward the poles, and is, apparently, at the limits of Buys Ballot's tables, viz., about 50° of latitude, in the southern hemisphere, 750 millimeters, but in the northern hemisphere 760.—*Oesterreich. Zeitschrift für Meteorologie*, X., 159.

THE SMALL OSCILLATIONS OF THE BAROMETER.

Hon. Ralph Abercrombie has examined the connection between the wind and the small oscillations of the barometer. He finds, for example, that with an open window looking south and the wind nearly south, in strong gusts the first movement of the barometer is always upward, and about one tenth of an inch, as if the effect of the wind on being resisted by the house was to compress the air in the room. In a corner house, one window open to the south and another to the west, the wind south, in strong gusts, with the west

window open, there were violent oscillations; but the first movement was always downward. Upon opening the south window as well as the west, the oscillations ceased. It is well known by medical men that some acute diseases are aggravated by strong winds; and the author has observed that this distress is associated with those small oscillations of the barometer. He suggests the following practical method of palliation. If windows can not be borne open, try, by closing or by otherwise arranging windows and doors, to diminish the distress. When, as in most cases, windows can not be opened, all doors and windows should be closely shut, as well as the vent of the chimney if there is no fire; and, if possible, the patient should be removed to a room on the lee side of the house.—12 *A*, XII., 78.

ON THE DISTRIBUTION OF BAROMETRIC PRESSURE IN EUROPEAN RUSSIA.

The well-known work of Buchan, published in 1866 by the Royal Society of Edinburgh, was the first that offered an extensive collection of barometric observations, and gave the first approximate idea of the correct isobaric lines throughout the whole world as drawn for every month in the year, and for the average of the entire year itself. While Buchan in this work sought to obtain greater accuracy by using only the observations made between 1850 and 1860, he was, however, frequently thrown into serious error by the uncertainties of the altitudes above sea-level of the stations in the interior of Europe and America. For the latter country annual barometric means have been of late published by the Army Signal-office; and we have now to record the appearance of an important work by Rikatcheff, on the distribution of barometric pressure in the interior of European Russia. The author states that, as regards Asiatic Russia, we have still too little material to justify the drawing of isobaric lines as Buchan has done. For European Russia he gives many, and in some respects important corrections to the figures employed by Buchan. Having personally inspected many of the Russian stations, Rikatcheff has been able to discriminate between the observations that are reliable and those which should be rejected; he has collected all the valuable barometric observations that have been made in

Russia, and has applied to those stations whose altitudes were correctly known by levelings the barometric reductions (as computed by Rühlmann's formula) necessary in order to reduce the observed pressures to the theoretical sea-level. The highest station to which he has applied this process is Tiflis, whose altitude is about 1500 feet, and at which altitude he states the reduction to sea-level already becomes quite uncertain. The longest series of observations employed by him is, for the Russian stations, that at Warsaw, embracing thirty-three years. Having reduced the annual pressures to sea-level for these stations, he has, by means of preliminary approximate isobars, determined the mean annual pressure at sea-level for the other stations whose altitudes were not correctly known, and has there computed the altitudes as dependent upon long series of good observations, of five interior stations, with a probable accuracy of less than forty feet, and has determined the altitude of eight other stations with an error of less than ten feet. These secondary stations thus became valuable in the formation of the monthly isobars, although, of course, they can not be used on the annual charts. The final charts thus completed by Rikatcheff present the same phenomena as those given by Buchan, but of not quite so extreme a nature. The change from a very high pressure in the interior of the continent during the winter to a low barometer in the summer time is very decidedly marked (the explanation of this phenomenon given by Rikatcheff is too much at variance with mechanical laws to escape severe criticism). On the other hand, the annual chart shows a well-marked diminution in the average barometric pressure as we proceed northward. Its depression he attributes to the numerous cyclones that occur in this region, although he states very plainly that the average annual temperature, as well as the tension of aqueous vapor, should conspire to annul this effect. It is probable that at the time of composing his memoir he had not yet become acquainted with the writings of Ferrel, Thomson, Peslin, Colding, Everett, and others, by whom the depression of the barometer in the polar regions of the earth is very accurately explained as due to the rotation of the earth on its axis, combined with the general atmospheric currents. Ferrel has even explained, in a very perspicuous manner, the reason why this depression is

so much greater in the antarctic than in the arctic regions. One of the most important practical results attending the publication of Rikatcheff's memoir is the stimulus that it has given, and probably will give, to the application of Rühlmann's methods for the determination of altitudes by means of the barometer. According to this author, we should, if possible, employ only monthly or annual means for determining altitudes barometrically, and should (especially when only a few observations are available) employ the readings of the barometers at two or more known stations in order to deduce therefrom the temperature of the air without relying on thermometric observations. From the isobaric charts given by Rikatcheff we can find the average normal height of the barometer for any month whatever in Eastern Russia within less than one twenty-fifth of an inch, and in Western Russia within one fiftieth of an inch, and the average annual mean pressure of any point in Western Russia within one one-hundredth of an inch.—*Wild's "Repertorium,"* IV., art. 6.

ON THE TIDES IN THE ROADSTEAD OF FIUME.

In a recent prize essay by Professor Stahlberger on the tides in the roadstead of Fiume, the author, from a study of observations extending over thirty-seven lunations made by means of a self-recording tide-gauge, shows that with a rising barometer there occurs a diminished height of water, and, conversely, with a diminished pressure an increased height of water. In connection with the barometric pressure, the northerly and southerly winds exert their influence to respectively increase and diminish the water level. With the southern winds, the curves showing the height of the water are comparatively smooth and regular. With the northerly winds, however, they vary according to the strength of the wind, showing greater or less irregularities. The periodic movements of the ocean level are subject to two principal oscillations, depending on the moon, and two other principal ones depending on the sun. The regularity of this phenomenon is complicated very much by the fact that the tidal waves that reach Fiume come from the Mediterranean. The reason why the twenty-four-hour oscillation is comparatively large, while the twelve-hour is weak, depends, according to Stahlberger, upon the configuration of the Adriatic Gulf.

It is probably thus that we explain the fact that the ratio between the mean influence of the sun and the moon is, for Fiume, 1.86, instead of its theoretical value, 2.55, as was to be expected. The known effects of the tides at Trieste are similar to those at Fiume.—"*Mittheilungen*" *Austrian Hydrographic Office*, 1874, 723.

THE DIURNAL AND ANNUAL PERIODICITY OF THE MOISTURE IN RUSSIA.

Professor Wild, of St. Petersburg, has communicated an extended investigation into the atmospheric humidity as recorded at the Russian meteorological stations, a study which may be looked upon as a continuation of his previous memoir on the distribution of cloudiness in Russia. He finds that the diurnal changes in relative humidity are intimately connected with diurnal changes in temperature, so that a maximum of temperature coincides with a maximum relative humidity, and *vice versa*. Furthermore, the amplitude of the daily oscillation in humidity has direct relation to the changes in temperature. The diurnal changes in absolute humidity have, however, a much less decided connection with the temperature. The annual changes in both absolute and relative humidity are given by monthly means for forty-one stations. The annual changes in absolute humidity may be directly connected with the temperature. The causes of the various annual changes in humidity in different portions of Russia are explained by Wild in connection with the seasonal distribution and changes of atmospheric pressure and winds.—*Oesterreich. Zeitschrift Meteorologie*, X., 258.

ON THE ACCURACY OF ANEMOMETERS.

One of the most important and, at the same time, popularly interesting matters relating to meteorology, or rather to the mechanics of gases, is the relation between the pressure and the velocity of winds; which subject, notwithstanding the elaborate researches, both experimental and theoretical, that have been made since the days of Lambert, is still far from being satisfactorily resolved. The numerous experiments seem uniformly to show that the measured pressures of fluids against the surfaces opposed to them differs from

those predicted by theory. The principal source of discordance is probably to be found in the fact that the computations take account only of the pressures against the front surface of the solid, while the reaction that takes place on the hinder surface is partly or even totally neglected. In the case of the anemometers employed for the purpose of measuring the velocity of the wind, probably without a single exception, their indications must be interpreted by means of approximate empirical formulæ; and no other method has, as yet, been devised by which the indications given by pressure gauges can be compared with those given by velocity meters. Of these latter instruments, the best are those known as Robinson's anemometer and the Casella anemometer. Of the pressure gauges, those most commonly in use are the Ossler anemometer and Wild's anemometer. Dr. Dohrandt has recently undertaken, at the instigation of Dr. Wild, of St. Petersburg, an elaborate investigation, both theoretical and experimental, into the sources of error peculiar to these instruments; and the memoir embracing his results, which was announced a year ago by Professor Wild, seems to be the most valuable contribution to anemometry that we have had occasion to regard since the appearance, in 1873, of Cavallero's investigations, which were noticed by us at the time. (See *Annual Record*, 1874, p. 104.) Unfortunately, Dr. Dohrandt was interrupted in his labors by a call, on the part of the Russian Geographical Society, to superintend the establishment of meteorological stations in Asia; but Professor Wild assures us that his researches will be continued by the Physical Observatory, until definite conclusions can be considered as established. Among the means adopted for comparing the actual velocity of the wind with the readings of the anemometer, Dr. Dohrandt experimented first with the method adopted thirty years ago by Duchemin, and less thoroughly by others, and which consists in carrying an anemometer attached to a locomotive, the velocity of whose movement is well ascertained. The railroad from St. Petersburg to Tsarskoe Selo offered a good opportunity for the experiment which was first made on July 1, 1871, in which the average velocity of the railroad train seems to have been from twenty-one to forty-eight kilometers per hour. During the experiment the average velocity of the wind itself, in

the direction of the path of the locomotive, was two and eight-tenths kilometers per hour; and the velocities observed by timing the train as it passed each mile-post agreed with the velocities recorded by the anemometer to within two per cent. A more definite method of investigation, however, is that of Combes, which consists in attaching the anemometer to a long arm, which latter is made to revolve in a circle at a known rate, in a space where strong currents of air do not occur. Velocities up to forty kilometers per hour were attained in this way by Dohrandt; and from the investigation of six different Robinson's anemometers, and of two of Casella's instruments, and of a number of electric recording anemometers, it was concluded that the arithmetical mean of the indications of an anemometer, when the arm which carried it revolved in both a positive and a negative direction, might be adopted as the result that would be given if the instrument had simply moved in a straight line. The determination of the effect of the moving anemometer upon the air surrounding it—an effect which it is known consists essentially in carrying the air with it, and thereby diminishing the relative velocity of the air and the instrument—was first made by placing a Casella and a Woltman's anemometer on the same level with the rotating anemometer, but fixed in their positions, and so near to the circle described by the latter that they could feel the influence of the wind dragged along by the Combes' apparatus, and be thereby set in motion. As the result of this portion of his investigation, Dohrandt finds that the wind due to the dragging influence of the moving anemometer is very approximately proportional to the velocity of the latter itself. As a final result in reference to the velocity of the anemometers, Dohrandt gives a formula applicable to each one individually, by means of which the true velocity may be computed from the indications of the dials of the instruments. Having thus some half-dozen well-investigated instruments as standards, it becomes easy to compare numerous others with these. The result of such comparison showed that the errors determined in this secondary manner were of the same nature and expressed by the same formula as those determined by the original investigations. In general, in relation to the velocity of the anemometers, Dohrandt finds that the

centre of the revolving caps of the Robinson instrument, instead of describing exactly one third of the path of the wind, as they should do according to the theoretical researches of that astronomer, differ from this to such an extent that the indications of their dials must be multiplied by numbers varying from 2.1 to 2.9 in order to deduce the true velocity of the wind. The result most to be desired in relation to this branch of anemometry is the determination of the relation between these varying factors and the actual dimensions of the respective instruments. But Dr. Dohrandt finds, as had Cavallero and Stowe before him, that no such relation can be discovered; only so much is easily seen, that the magnitude of the factor is in more direct connection with the diameter of the hemispherical caps than with the length of the arms of the anemometer. In respect to the pressure of the wind, Dohrandt experimented with six different specimens of Wild's wind-pressure anemometer, which consists simply of a very thin plane piece of iron or wood, or thin cardboard, hanging by a very thin arm from a pivot, and which is by the force of the wind pushed aside from its vertical into an inclined position. The angular extent of the deflection is measured in degrees by an appropriate divided arc. In connection with this, he calls attention to the fact that the indications of this, and of all pressure instruments, are decidedly affected by the density of the atmosphere, as indicated by the barometer. The comparisons of the indications of this pressure gauge with the velocity deduced from the standard anemometers seems to show that the simple instrument of Dr. Wild suffices, by means of the table given by Dohrandt, to determine the velocity of the wind within less than about one half a meter per second. On account, therefore, of its simplicity and inexpensiveness, it is probable that this instrument will be widely used throughout the world, especially as it has now been introduced at all the Russian meteorological stations, and at many of those in southern Europe.—*Wild's "Repertorium,"* IV., art. 5.

THE SELF-REGISTERING BAROMETER OF REDIER.

Among the many contrivances brought forward during the past few years for the self-registration of meteorological instruments, that of Redier seems both economical and ap-

plicable to many cases where more troublesome apparatus would be out of place. His arrangement consists essentially in such an alteration of the well-known printing barometer constructed by G. W. Hough, of Albany, that the use of electricity is done away with, and, on the other hand, the fulcrum of the principal lever in the apparatus is fixed, while the barometer tube itself, or the aneroid box, moves. The numerous specimens of the apparatus constructed by Redier for individuals in France seem to have given very general satisfaction, and the instrument has been highly commended to the attention of French observers. It consists essentially of a clockwork by means of which a cylinder is made to revolve uniformly, carrying with it a sheet of paper upon which the record is to be made. Above the cylinder stands the barometer, which is so arranged that the rise and fall of a thousandth part of an inch causes a lever to rise or fall by a corresponding movement, thereby releasing the detent of an auxiliary piece of clockwork, which is thereby at once set in motion. The movement of this clockwork allows the barometer tube itself to fall or rise, thereby again interfering with the movement of the clockwork and automatically stopping it. Meanwhile the up or down movement of the barometer has been closely followed by the corresponding movements of a pencil, whose mark on the sheet of paper produces an exact record of the extent of the barometric change.—13 *B*, III., 267.

DO STORMS CROSS THE ATLANTIC?

Mr. Ley states that, having worked for a considerable time at the comparisons of United States with European weather charts, he concludes that only a small portion of the storms experienced on the American side of the Atlantic can subsequently be distinctly traced in Europe. Of those thus traceable the majority are felt severely in the extreme north of Europe. The rapidity of the progress of these storms across the Atlantic varies indefinitely, and could not be deduced, as Mr. Draper has attempted, from the velocity of the winds experienced in them. Many of the most destructive European storms occur when the barometric pressure over the eastern portion of the United States is tolerably high and steady, and they appear to be developed upon the Atlantic

Ocean, near the eastern limits of the area of high pressure.—12 *A*, 405.

GLACIATION OF ICELAND.

In the opinion of Mr. William L. Watts, who is engaged in making some explorations among the glaciers of Iceland, these are increasing year by year; and he thinks that at no distant period the whole island will be covered with ice, as is the case with Greenland.—13 *A*, 193.

GLACIERS OF THE HIMALAYAS.

At the recent meeting of the British Association Colonel Montgomerie gave an account of the glaciers of the Himalayas, which are most developed in Baltistan, in Northwestern India. According to his statement, these glaciers gradually increase in size from east to west, many of them being more than twenty miles in length, and one, Biafo, thirty-four miles. The thickness of the ice was in some cases found to be 400 feet. The phenomena of progress, etc., were found to be similar to those observed in the Alps.—15 *A*, *September* 4, 314.

TIDES OF THE MEDITERRANEAN.

The tides of the Mediterranean form the subject of a prize essay by Stahlberger, of Hungary. The author especially dwells upon observations and discussions relating to the peculiar local influences in the neighborhood of the port of Fiume, on the shores of the Adriatic. Pursuing an inductive method, he shows the existence of general changes of the water produced by cosmical causes, and local changes due to meteorological or local agencies. Of the former there are principally two oscillations dependent on the sun, and two on the moon. The local changes are caused chiefly by variations in the wind and the barometer. In stating this view, he seems not to have gone beyond what Mr. Ferrel has already published with reference to the Atlantic.—"*Mitth.*" *Austrian Hydrogr. Office*, II., 723.

DAILY WEATHER CHARTS.

The dissemination of valuable meteorological intelligence has been remarkably facilitated in England by the daily publication, in the London *Times*, of a small weather chart, show-

ing the temperature, wind, barometer, and weather, and the condition of the sea for the region within about five hundred miles of London. This chart is prepared daily by the London Meteorological Office, and furnished gratuitously to the newspapers. The stereotype plate, fit for use in a Walter printing-machine, is produced in about an hour. It is now more than four years since a similar undertaking, on a somewhat different scale, was set on foot by Sir William Mitchell in the *Shipping Gazette* of London, and which has been continued daily.

CONNECTION OF WEATHER AND COLLIERY EXPLOSIONS.

Messrs. Scott and Galloway, of England, have continued their researches into the connection between colliery explosions and the weather. As the result of the study of two hundred and twenty-four explosions, they state that the amount of fire-damp recorded in the mines increases and diminishes directly as the barometer falls and rises, proving beyond the possibility of cavil that the variations of atmospheric pressure have a marked influence on the rate at which fire-damp escapes from fissures. In the large majority of the fatal explosions the miners were using naked lights; and they suggest that if fire-damp is known to be present in any part of the mines, then either the workmen should not be allowed at any time to be near it, or else they should use safety-lamps in its vicinity, at least during the continuance of the barometric depressions. They also suggest the interest and value that would attach, both in a scientific and a practical point of view, to the keeping at coal-mines of barometric records, such as are daily furnished by the self-recording apparatus which can now be obtained from every meteorological office.—*Quart. Jour. Met. Soc., London*, II., 195.

THE HOURLY DISTRIBUTION OF RAINFALL.

Among the very few meteorological stations at which the rainfall has been recorded either continuously or hourly is to be noted that of Berne, in Switzerland, the observations at which place for the past eight years have recently been studied by Forster. The diurnal periodicity of rainfall, both as regards its quantity and its frequency, follows at this place a regular law, and, on the average of the year, it is shown

that the probability of rain increases from one o'clock in the morning to a maximum at seven o'clock in the morning, then sinks to a minimum at two o'clock in the afternoon, and rises again to a maximum at midnight. The diurnal period is thus almost opposite to that which obtains under the tropics, where in the afternoon, at the hour at which the temperature is at its maximum, and at which the clouds are, on the average, the highest above the earth, it rains most frequently.—19 *C*, VII., 234.

PERIODICITY OF SEVERE WINTERS.

A memoir by Rénou, the distinguished French meteorologist, upon the periodicity of severe winters, although published many years ago, has been recently quoted in defense of the opinion that such periodicity actually exists. According to Rénou, rigorous winters return about every forty-one years. They are arranged in groups, generally composed of a central winter, and four or five others disposed on either side of it, within a space of twenty years. Mixed with these years are others, also, of unusual warmth, in such a manner that the mean cold of the season is not sensibly altered. The period of forty-one years seems to be that which corresponds to the maxima of the solar spots at the same season of the year. A central cold winter arrives eighteen months after the maximum of spots has coincided with the warmest season of the year. The severe winters seem to alternate between the northern and southern hemispheres of the earth. —13 *B*, 135.

ORIGIN OF THE CENTIGRADE THERMOMETER SCALE.

According to the historical notes contained in the meteorological observations of Lafou, president of the Meteorological Commission of Lyons, the first thermometer that was ever seen at Lyons was brought thither in February, 1736, by Duhamel, to Father Duclos, director of the observatory founded by the Jesuits in the chapel of their college. This thermometer was constructed with alcohol, according to the principles of Réaumur, and was used for some time. A member of the Academy of Lyons, named Christin, replaced the alcohol by mercury, as had, indeed, previously been done by Fahrenheit in 1724, and by Dr. Sauvage at Montpelier in

1736. Christin having introduced into a tube terminated by a bulb a quantity of mercury, whose volume might be represented by 6600 at the temperature of freezing water, found that this volume became 6700 when the tube was plunged into boiling water. The alcohol of the original thermometer being thus dilated 100 parts, Christin divided the corresponding space passed over by the mercury into 100 equal parts, remarking that these new divisions, being smaller than those of Réaumur, would be more in harmony with the sensations caused by variations of temperature. Such was the origin of the Centigrade thermometer, which was afterward known for a while under the name of the "Thermometer of Lyons." Four years after—that is to say, in 1746—Cassini, who was a well-known optician at Lyons, had sold seven hundred of these in Paris, besides others in Provence and Dauphiny.—13 *B*, III., 94.

PERIODICITY OF HAIL-STORMS.

The tendency which has been so marked of late years to look for a periodicity in almost every natural phenomenon corresponding to the periodical increase and decrease of the solar spots, seems to have been carried to its fullest extent in the recent suggestion of Professor Fritz, according to whom the frequency of hail-storms has some connection, accidental or otherwise, with the frequency of solar spots. He finds, by collecting the records from twenty-five different European and other stations, that all observations show that the years of greatest frequency since 1806 have been 1817, 1830, 1838, 1848, and 1860, which years follow or are nearly coincident with the sun-spot maxima of 1817, 1829, 1837, 1849, and 1860; whence it would follow that the year 1871, a year of sun-spot maximum, should be also a year of frequent hail-falls, as actually was generally recorded. Furthermore, seasons of infrequent hail-storms correspond to the minimum of solar spots, as in 1810, 1823, 1834, 1844, and 1856. It has also been often remarked that a winter of extensive or frequent auroras is followed in the succeeding summer by unusual hail-storms. The connection between auroras, lightning, hail, and cirrus clouds and the solar spots seems, therefore, worthy of further study.—7 *C*, XV., 244.

FIGURES MADE BY LIGHTNING.

Professor Tomlinson, in writing on the subject of the figures or marks left on the bodies of men or animals killed by strokes of lightning, states that very instructive tree-like figures may be produced on sheets of ground glass by passing over them the contents of a Leyden-jar. These figures, like those on the human subject, are not derived from any tree whatever, but represent the path of the lightning itself. This subject has been studied by numerous authors; among others by Poey, who, in 1861, published a small volume, in which twenty-four illustrative cases are cited. He accounts for their formation as a photo-electric effect, in which the surface of the animal is the sensitive plate, the tree, etc., the object, and the lightning the force that impresses it. Among many remarkable cases that can be quoted was one that occurred at Zante, where the mast of a vessel was struck, and a sailor sleeping in a cot on the deck was killed. The number 44, in metal, was attached to the fixed rigging between the mast and the cot. On the left breast of the dead sailor was found the number 44 well formed, and perfectly identical with that on the rigging. Light was thrown upon these cases by Mr. Varley, who, noticing some specks on the metallic ball of the positive pole of a Holtz electric machine, tried to wipe them off with a silk handkerchief, but in vain. He then examined the negative pole, and discovered a minute speck corresponding to the spots on the positive pole. It was evident that lines of force existed between the two poles, by means of which, as it were, telegraphic communication was made from one to the other; and in explanation of the marks made on the human subject, it is stated that a lightning burn on the skin is produced whenever the object struck is electrically positive to the metallic object, the discharge itself being a negative one.

CLIMATOLOGY OF FLORIDA.

In an address on the climatology of Florida, recently delivered by Dr. Baldwin, the author gives some interesting statistics, whose value is indicated by the fact that they are based upon thirty-six years' meteorological observations, recorded by himself, at Jacksonville, together with numerous

shorter records from the stations in other portions of the state. He states that the first frost has occurred in the fall in October four times in the course of these records, in November sixteen times, and in December seven times. There have been several years in which there have been no frosts in October. There have been three years in which none has occurred in November nor December. Of late frosts he says that there have been very few in April, and none after that. The latest on record is that on the 28th of April, 1858. There have been but four Aprils and but four Octobers in which frosts have been recorded. From these statements an idea can be formed of the average amounts of freezing weather in winter. Frosty days occur, on the average, about five days in each of the months of December and January. As to clear days, he states that from November to March there is an average of twenty clear days per month; but for June, July, August, September, and October an average of from seventeen to nineteen days. Of rainy days there are in January six or seven, in February three or four, in March five or six, and in December five. "I judge," Dr. Baldwin says, "that, on the whole, the preponderance of clear over rainy and cloudy days speaks decidedly in favor of our climate as being characterized by a fair amount of pleasant weather. The excessively cloudy weather of January, 1875, is a marked exception to all former years since my residence in Florida, and has most probably resulted from some general disturbance of the atmosphere, which has produced such intense cold in the Northern States as will probably be remembered hereafter as one of those cold winters which at long intervals will visit a country, and which on many accounts may be considered as a 'blessing in disguise.'"—*Baldwin's Address*, 1875.

C. GENERAL PHYSICS.

ATTRACTION AND REPULSION RESULTING FROM RADIATION.

Mr. Crooks has lately published his investigations into the phenomena known as attraction and repulsion resulting from radiation. The apparatus constructed by him appears to be more sensitive than the ordinary thermo-multiplier. He considers that the experiments show that the repulsion is not entirely due to the rays usually called heat, viz., to the extreme and ultra red rays of the spectrum. The theory advanced by Professor Reynolds to explain his observations is not acceptable to him, although, on the other hand, he has not yet prepared one of his own. According to Reynolds and Balfour Stewart, these experiments constitute a direct proof, and the only known direct proof of the truth of the kinetic theory of gases as developed by Clausius and Maxwell.

Mr. Crooks has adapted his results to the construction of a very important instrument, which he calls a radiometer. It consists of four arms suspended on a steel-pointed axle resting in a cup, so that the arms are capable of revolving horizontally. To the extremity of each arm is fastened a thin disk of pith, lampblacked on one side, and the whole is inclosed in a very perfect vacuum within a glass globe. Under the influence of light, or heat, the little arms revolve with considerable rapidity. Mr. Crooks states that the repulsion experienced by these disks when any radiation falls upon them is proportional to the length of the vibrations, and varies at every point of the spectrum. Professor Guthrie has remarked that Mr. Crooks's research had, in an almost unequaled degree, every element of greatness.

INCREASE OF RADIATION WITH TEMPERATURE.

It is well known that as the temperature of a solid is gradually increased, the refrangibility of the emitted light increases likewise, and as the result we find red light emitted first; afterward the other colored rays gradually appear as the heat increases, until we reach the ultra-violet rays. This correlation between refrangibility and temperature was first

experimentally proved by J. W. Draper, and it would be a result of great importance to determine the law of growth of refrangibility with temperature. If this could be achieved, a very convenient and accurate pyrometer could be made of the ordinary spectroscope. An accurate investigation of this subject has been undertaken by a committee of the British Association, which has in a preliminary report presented some observations on the simple increase of radiation with temperature. On this subject Becquerel has a great number of observations, whence he infers that the differences between the logarithms of the luminous intensities are proportional to the differences of temperature, a law which he thinks would hold up to 1200 degrees Centigrade; but the law as thus expressed mathematically by no means represents the true rate of increase of the total luminous intensity, which is, indeed, very much slower than that required by Becquerel's law. Again, if the law of Dulong and Petit for the velocity of cooling be true, then the amount of heat radiated, as also the temperature, could be calculated; but on comparison with actual observations at high temperatures it is found that their law gives too rapid an increase for the total radiation. Assuming, however, these laws to be even approximately correct, we may calculate the hypothetical temperature corresponding to the brightness and total radiation from the sun, and deduce in one case for the solar temperature 13,000, and in the other case 11,000 degrees Centigrade. —*Report of the British Association*, 1873, 461.

THE DIFFUSION BETWEEN DRY AND MOIST AIR.

An investigation that may have some interest in the future of meteorology has been conducted by Dufour, who has examined the question of the diffusion between dry and moist air traversing a porous disk. He finds that the activity of the diffusion does not depend directly, except possibly in a very slight degree, upon temperature. If we compare the observations made at different temperatures, we find that the activity of the diffusion also does not depend, with slight exception, upon the relative humidity; it depends principally upon the difference between the quantities of vapor, or the tensions of the vapor, on the opposite sides of the disk, and is in fact very nearly proportional to the difference of the ten-

sions. If, then, we compare observations made at the same temperature, the activity depends upon the relative humidity of the two portions of air. The study of the influence of the diaphragm, its extent, etc., has enabled him to explain how a small porous vase can, by connecting its interior with a manometer, be utilized in studying the diffusion of vapor in the free atmosphere. Similarly, we may determine the tension of the vapor of water existing in the air, at any moment, by determining the difference of the pressures shown by the monometer in the interior, and by the barometer on the exterior. This suggests a new hygrometer, which, simple as it is, and easily applicable, may rapidly find favor among meteorologists so soon as Dufour has exactly developed the laws connecting the relations of pressure and the hygrometric state of the atmosphere.—*Bibl. Univers. et Revue Suisse*, 1874, 336.

ON THE LAWS OF APPARENT ADHESION.

Stefan, who is well known as one of the most industrious investigators in all matters relating to molecular physics, has recently published in full a memoir relating to preliminary investigations on the subject of adhesion. The true phenomena of adhesion are easily confounded with what he calls apparent adhesion. That is to say, if two perfectly flat plates be brought quite near together, but not in actual contact, and an attempt be made to separate them, a slight force is required, which Stefan states, on further investigation, he is persuaded is simply the result of the resistance which the viscosity of the liquid or gas offers to its immediate inflow into the space between the two disks. The effect of this viscosity, of course, would disappear if the experiment could be performed in an absolute vacuum. On the other hand, the study of the experiments made by Stefan in the atmosphere at its ordinary pressure, and of such liquids as alcohol, water, solutions of salt, etc., has enabled him to determine the true co-efficient of viscosity or internal friction for these substances. The values he arrives at are, for water, 0.0108, for air, 0.00183; figures which agree exactly with those deduced by Maxwell and Meyer by entirely different methods of experiments. The actual separation by means of a slight force of the disks experimented with by Stefan is, he states, a dynamic, and not a static phenomenon. The time

required in order to separate these plates through a given distance was inversely proportional to the force that was applied. It increased nearly as the inverse square of the original distance between the plates, and as the fourth power of the radius of the plates; and in whatever liquid he immersed his plates, the times were proportional to those required by equal volumes of these liquids to flow through capillary tubes.—19 *C*, VIII., 60.

THE DISSIPATION OF ENERGY.

In some remarks on the dissipation of energy, Lord Rayleigh states that the chemical bearings of this subject are very important. A chemical transformation is impossible if its occurrence involves the opposite of dissipation; but it is not true that a transformation which involves dissipation must necessarily take place; otherwise the existence of explosives, like gunpowder, would be impossible. The possibility of chemical action must often depend upon the density of the reacting substances. Thus, in the case of a mixture of oxygen and hydrogen in proper proportions at a certain density, the mixture may be exploded by an electric spark, and energy be dissipated; but beyond a certain point of rarity the explosion can not be made, as it could not then involve any dissipation. It may probably be found that many mixtures which show no tendency to explode under ordinary conditions, will become explosive when sufficiently condensed.

THE TRANSMISSION OF MECHANICAL POWER BY MEANS OF ELECTRICITY.

Magneto-electric machines have not yet attained that point of perfection which permits them to be placed among the industrial apparatus; but they at least offer a method of producing electricity very economically. The principal machines are those of Siemens and Halske, of the French Society of L'Alliance, and of Gramme. The currents produced in the last-named machines are analogous to those furnished by the galvanic battery, thus permitting its application to all works where voltaic electricity is useful. The Gramme, as adapted for electro-plating in the silver-works of Christoffle, of Paris, has a height of four feet and a

length of two and a half feet, and the resulting electric current deposits eight hundred grammes of silver per hour, requiring a motive force of one horse-power. The experiments made at London by this machine give it the first rank among apparatus for producing electric light. A curious experiment was performed with one of these machines at the Exposition of Vienna. The principal magneto-electric machine being driven by an air-engine on the Lenoir system, the electricity thus produced was carried to the electro magnets of two Gramme machines of more feeble dimensions, which, acting as an electric motor, kept a small centrifugal pump in action. Thus the mechanical effect of the electricity was by the connecting wires carried to a great distance from the motor. The principal advantage of the transmission of force by electricity is found in the possibility of overcoming vertical spaces which are inaccessible to the cables or belts in use in manufacturing works. —*Bulletin Hebdomadaire*, XVI., 8.

CRYSTALLIZATION ILLUSTRATED BY THE MICROSCOPIC PHOTOGRAPH.

It is often very important in chemistry or in crystallography to be able to seize exactly the delicate forms of crystals, as examined by the microscope; but the most conscientious draughtsman can not always reproduce the fineness of these crystallizations. According to Girard, many crystals can be photographed. As a preliminary, it is necessary generally to dilute the solution to different degrees, and to allow one specimen of each kind of crystal to be formed by itself. We thus acquire the faculty of choosing that degree of concentration where the crystallographic characters are most appropriate to the methods of photography, either by reason of the delicate grouping of the forms, or by their transparency to the penetration of light. The most simple method of photographing the crystals consists in the use of an ordinary microscope, the body of which is placed in a horizontal position. In a dark room upon a table near a window the microscope is placed, and the object is illuminated by a beam of light coming through the window from a heliostat without. The luminous rays pass through the thin film of water containing the crystallized salt, traverse

the objective of the microscope, and form a magnified image upon a distant screen. At the proper moment we substitute for the screen a sensitized photographic plate, and obtain a photograph by the ordinary processes. A number of pictures should be taken of the same object, in order to choose among them that which presents the nature of the crystalline system under the best conditions. This precaution is especially necessary in certain products, where the solution gives results distinct from each other, according to the degree of saturation.—13 *B*, III., 171.

EBULLITION PHENOMENA.

Dr. Phipson states that water strongly acidified with hydrochloric acid, and containing a small quantity of benzol, when placed over a spirit-lamp enters into a violent ebullition every sixty seconds. After a while the boiling ceases completely, and then recommences suddenly every thirty seconds, for a considerable period. The flask still being kept over the spirit-lamp, the periods between quiescence and violent ebullition dropped to twenty, ten, and finally to eight seconds, at which intervals the phenomena continued for a considerable time.

When methyl alcohol was added to the above mixture of water, hydrochloric acid, and benzol, and the flask placed over a spirit-lamp, no ebullition at all occurred for a long period of time, and then it took place suddenly and continued. —1 *A*, *April* 23, 177.

ON THE RELATION BETWEEN SPECIFIC GRAVITY AND MAGNETISM OF IRON.

From a number of experiments on the magnetism of iron and steel, Holtz concludes that galvano-plastic iron receives when made to glow by a galvanic current a greater specific gravity. The molecules are brought closer together, the intervals between them become smaller, and the permanent magnetic moment is diminished by one half. On the other hand, steel bars by being heated red-hot, and tempered, acquire a smaller specific gravity, the molecules are farther from each other than before, the intervals being greater, and the magnetic moment is notably increased. Again, Wiedeman has shown that permanent magnetism is diminished by

torsion, but temporary magnetism increases by detorsion. These effects can be explained by the same relation above found between density and the magnetic force of iron. The torsion increases the density of the iron, and the magnetism must therefore diminish. By detorsion, the molecules of the magnets are separated from each other, and the magnetism itself increases. It can, then, be assumed as probable that the magnetic forces in general are functions of the spaces between the molecules, and dependent upon the dimensions of these spaces.—19 *C*, VIII., 151.

RELATIONS BETWEEN CHEMISTRY AND THERMOTICS.

The study of the evolution of heat in chemical combinations is a new branch of science, belonging partly to physics and partly to chemistry, and the number of facts already observed is sufficiently numerous to indicate certain laws which are set forth by Berthelot. He premises that in the act of producing any chemical change, the molecules hit sharply against one another, and give off heat, just as when a hammer strikes a bar of iron. From the study of the relations between the amount of heat and the amount of work done, it is possible to establish some theorems of thermochemistry.—12 *A*, X., 473.

RELATIONS OF HEAT AND ELECTRICITY.

In a very suggestive article of Kohlrausch on thermoelectricity, he develops the hypothesis that currents of heat and of electricity are connected together in every conductor of heat, the heat being moved by an electric current whose heat-moving force is proportional to the electro-motive force of the heat current in the same body.—12 *A*, X., 278.

CONTINUITY OF THE LIQUID AND GASEOUS STATES OF MATTER.

Professor Andrews, of Belfast, at the meeting of the British Association in 1874, made a further communication on the continuity of the liquid and gaseous states of matter. As the result of some of his more recent investigations, he stated that the compressibility of sulphurous liquids, unlike that of water, diminishes as the pressure increases. A mixture of three volumes of carbonic acid and four of nitrogen was sub-

jected to a pressure of 300 atmospheres at various temperatures, from 2° to 48° C., with the very important result that, even at 2°, the carbonic acid of such a mixture could not be liquefied under any pressure. Indeed, the "critical point" of carbonic acid proves to be lowered many degrees when that gas is mixed with a non-liquefiable gas, such as nitrogen.—15 *A*, *Aug.* 29, 1874, 277.

THE FORCES DEVELOPED BY EVAPORATION AND CONDENSATION.

Professor Osborne Reynolds, in a careful review of the remarkable observations recently made by Mr. Crookes, shows that, according to the kinetic theory of gases, whenever a molecule of liquid is evaporated, and becomes a molecule of gas, it must leave the liquid surface with a velocity equal to that with which the other particles of the gas are rebounding among themselves; that is to say, instead of being first detached, it must be shot off with a velocity greater than that of a cannon-ball, and there must be an equal reaction on the surface of the remaining liquid; the contrary effect takes place in the case of condensation. Applying the necessary mathematical formulæ, he finds that, at a temperature of 60°, the evaporation of one pound of water from a surface is sufficient to maintain a force of 65 foot-pounds for one second, the force being proportional to the square root of the absolute temperature. In the case of mercury the force is only 6 foot pounds instead of 65. And again, whenever heat is communicated from a hot solid surface to a gas, an effect similar to that of evaporation is produced, while for every English unit of heat communicated to steam, at a temperature of 60°, the reaction on the surface is equivalent to 0.38 of a pound acting for one second; but is, for air, 0.55 of a pound.—12 *A*, X., 175.

THE HEAT PRODUCED BY GALVANIC CURRENTS.

Since the galvanic effect upon metal wires, by means of which they are made to glow, has acquired a practical importance in galvano-caustics, it appears desirable to present, in the clearest manner, the connection between the power of the battery, the dimensions of the wire, and the resulting phenomenon; and the first attempt at a partial solution of

this problem appears to be due to Professor Müller, of Freiburg. According to him, we obtain a measure of the intensity of the glow by dividing the intensity of the galvanic current by the diameter of the wire; the current intensity being given by Ohm's law, we of course find that the effect will depend upon the number of elements in the galvanic battery, and the electro-motive force of each element; also upon the resistance of the wire and the battery. For the same battery acting on the same length of wire a maximum glow will be produced when the wire has a certain determinable diameter, and the intensity of the glow diminishes when the wire is either thicker or thinner than this. For instance, with six of Ruhmkorff's zinc and carbon elements acting on a platinum wire one decimeter long, the maximum glow is produced when the diameter of the wire is $\frac{1}{3}$ of a millimeter; for a wire two decimeters long the thickness must be $\frac{1}{10}$ of a millimeter to produce the maximum effect. With a battery of two of Stohrer's elements a platinum wire, two decimeters long, can not be raised to a white-hot glow, but may be raised to a red heat when its diameter is $1\frac{1}{2}$ millimeters, or less. Again, in order to make red hot a platinum wire of $\frac{1}{4}$ millimeter diameter and two meters long, a battery of 28 elements is necessary, while 40 such will not make this wire white hot.—*Berichte d. Naturf. Gesell. Freiburg*, VI., 2, 97.

THE MOLECULAR CONSTITUTION OF GASES AND LIQUIDS.

That the same substance at the same temperature and pressure can exist in two very different states, viz., as a liquid and as a gas, is a fact of the highest scientific importance, for it is by the careful study of the difference between these two states and the phenomena which occur at the surface which separates the liquid from its vapor that we may expect to obtain a dynamical theory of liquids. A dynamical theory of perfect gases is already in existence; that is to say, we can explain many properties of gaseous bodies by supposing their molecules to be in rapid motion, and that they act on one another only when they come very near or strike each other; but we can not extend this dynamic theory from the rarer to the denser condition obtained by subjecting the gas to great pressure without at the same time obtaining some definite conception of the nature of the action

that takes place between molecules when they are only for an instant in close contact, which action, in fact, depends upon the particular constitution of the encountering molecules. The first contribution to a dynamic theory of liquids is made by Maxwell in some comments on the labors of Vanderwaals, where he takes occasion to show that we have evidence that the molecules of gases, besides encountering each other in their motions, also attract each other at a certain small distance, but when they are brought still nearer they repel each other, a conclusion in accordance with Boscovich's theory of atoms. On the other hand, the molecules of liquids, or even these same gaseous molecules, when reduced to the liquid condition, apparently repel each other at a certain small distance, which repulsive forces between contiguous molecules are overcome by the general attractions of the mass of the body.—12 *A*, X., 479.

ON THE REFLECTION OF SOUND FROM A LAYER OF FLAME OR HEATED GAS.

Mr. Cottrell has observed the reflection of sound from a coal-gas flame in the following manner: Sonorous pulses sent through an open tube agitate a sensitive flame placed at its other end; but when a coal-gas flame is placed between the end of the tube and the flame, the latter is no longer affected by the sound sent through the former. He then placed two tubes so that they were equally inclined to one face of the gas flame, and, sending the sound into one of these tubes, it was reflected from the flame, passed up the other tube, and agitated a sensitive flame placed at its mouth. In a similar manner he has shown that part of the sound is reflected from the flame, and part is transmitted by the flame, thus giving a complete analogy between the reflection of sound from a flame and the reflection of light from a transparent plate. He obtained the same effects, as given above, when he replaced the flame by the sheet of heated gases rising from it.

THE EVAPORATION OF METALS BY ELECTRICITY.

Mr. Hopkins describes an interesting experiment, which consists in passing a charge of electricity through a very fine thread of platinum, or other metallic foil, the thread

being kept in place between slides of microscope glass. The effect of the heat from the electric discharge is to vaporize the metal, which is instantly condensed in a transparent layer upon the cold glass, which can then be studied by the microscope, and can be used in various ways to determine the character of the metal and the peculiarities of the discharge.—12 *A*, X., 190.

STEAM FOG-WHISTLES.

It has been found by General Duane, of the United States Engineers, in his experiments made to determine the best form of boilers for steam fog-signals, that as the steam used is at a high pressure, and is drawn off at intervals, there is a constant tendency to foam and throw out water with the steam. To counteract this, a horizontal tubular boiler, like those used in locomotives, is recommended by him. The steam-dome must be very large, and surmounted by a steam-pipe 12 inches in diameter. The steam should be drawn off at a point ten feet above the water level in the boiler. The diameter of the boiler whistle should be two thirds of its length, and the vertical distance of its lower edge above the coping, for a steam pressure of 50 pounds, should be from one third to one fourth of the diameter.—*Elliot's European Light-house System*, p. 25.

THE GAS GUN FOR FOG-SIGNALS.

A very ingenious application has been made, by Mr. Wigham, of the explosive nature of a mixture of ordinary gas in air. He establishes at any point on the coast where a fog-signal is desired a gas gun. It is simply a tube of iron, connected with the gas-holder by the proper pipe; the holder, of course, may be at any convenient distance. The gas-holder is filled with a mixture of one fourth air, and the remainder coal-gas and oxygen, and this mixture is allowed to flow into the gas gun, when it may be fired off by touching a match to the proper orifice, taking care, of course, to close all communication with the holder. By using an electric spark, instead of the match, the service of the gun may be made still easier. The flash from this gun is said to illuminate the fog much better than that from a discharge of gunpowder.—*Elliot's European Light-house System*, p. 74.

A NEW FOG-SIGNAL.

Experiments made in England with gun-cotton in the open air are said to have demonstrated that a mass of ten ounces of compressed gun-cotton, fired by means of two ounces of dry gun-cotton, as a primer, the whole being detonated with fulminate of mercury, produced a discharge which could be heard very distinctly at a distance of ten miles in all directions. These results were so satisfactory that it has been determined to build a parabolic reflector of cast iron, by which the intensity of the sound of the explosion of a charge of compressed cotton placed in its focus will be greatly intensified in one direction. The trials of the adaptability of this device as a fog-signal will be made at the Royal Arsenal, Woolwich.—*The Engineer.*

NEW METHOD OF OBSERVING THE VIBRATIONS OF A TUNING-FORK.

A new method of determining the absolute number of vibrations corresponding to any musical note is described by Poske, and has a high value in comparison with those that have hitherto been employed, which may be classified as graphic, acoustic, and optic: the first of these three is comparatively rough; the use of the siren is a good example of the acoustic method, although its practicable employment is found troublesome; and of the optical, that of Lissajous is in high esteem. The new method proposed by Poske consists, first, in replacing the clock or chronometer by the electro-magnetic rotation apparatus of Helmholtz, whose velocity of rotation is extremely constant, and can be determined accurately to its ten-thousandth part. The essential portion of this apparatus consists in a centrifugal regulator, which diminishes the strength of the electric current by the diminution of the number of contacts, as soon as the velocity of rotation exceeds a certain limit. The observer examines, through a microscope, a minute bright point upon the vibrating rod or cord, which point by its vibrations appears as a bright line; and between the eye and the vibrating point there also rotates a disk perforated with a known number of slits. The combination of the revolving slits and the vibrating point causes the latter to appear to move

slowly to and fro, in periods similar to the acoustic phenomena known as "beats." It is evident that the number of vibrations of the point is determined by the velocity of rotation, the number of slits, and the duration of the beats, the accuracy of the method being very great.

In the application of his method of determining the time of vibration of a tuning-fork, Poske has also been able to show that the vibrations of the latter vary with the amplitude of the arc of vibration; that the durations diminish in a geometrical series as the amplitudes diminish; and that, in general, the change in duration is proportional to the first power of the amplitude, and not, as in the pendulum, in proportion to the square of the amplitude.—*Poggendorff Annalen*, CLII., 463.

THE ACTION OF ORGAN-PIPES.

Mr. Hermann Smith states as the result of experimental studies that within an organ-pipe the "air reed" vibrates in arcs whose extent diminishes as we increase the speed of the reed, or that the times vary with the amplitude; and to this he adds the remarkable feature that the motion of vibration is an activity tempered by rests, and that the note of every open organ-pipe is not single, but a concord of two tones.—12 *A*, X., 162.

EFFECT ON SOUND AND LIGHT OF THE MOVEMENT OF THE OBSERVER.

The long-vexed question as to the effect, upon observations, of the movement of the observer, and the source of light or sound, has been elucidated by Baron Eotvos, of Pesth, who, in a recent communication, extends his former investigations, and offers a satisfactory refutation of several objections that have been raised. According to him, in case the source of sound or light be moving, the intensity must be defined as the living force that would fall, in a unit of time, upon a unit of surface, parallel to the wave surface, if all vibrations were like those which are imparted to the surface at that instant in which the intensity is to be determined. The formula for the intensity in question, as deduced by Eotvos, shows that the movement of the observer has a decided effect upon the result; and by applying this

to the case of an observer moving upon a locomotive, with a velocity of a hundred feet per second, and listening to a sound whose origin moves at the same rate toward him, he finds the observed sound 0.8 times as loud as when both are at rest. A method is also explained by him, showing the possibility of testing his conclusions by experiments on the heat received and sent by moving bodies.—*Poggendorff Annalen*, CLII., 535.

THE THEORY OF RESONATORS.

Lord Rayleigh contributes an extract from a forthcoming work by himself on acoustics, in which he submits a new theory of the action of resonators, and opposes emphatically the general statement that a resonator augments the body of sound by offering a column of air which is capable of vibrating in unison with the original sounding body. The exceptions to this rule, he thinks, are very important in a theoretical point of view; and he prefers to reverse the statement, and to say that the neighborhood of a resonator in unison with a sounding body diminishes the loudness of the latter. The resonator, in fact, instead of augmenting the effect of a source of sound, annuls it altogether, so far as external space is concerned, by absorbing the condensations and rarefactions into itself.—*Phil. Magazine*, p. 419.

VIBRATION OF MEMBRANES.

In a paper read before the London Mathematical Society, Lord Rayleigh demonstrates the theorem that an increase in the dimensions of a vibrating system is attended by a rise in pitch. For instance, if the system consists of a uniformly stretched membrane, with a fixed edge, it follows that any contraction of the boundaries must cause an elevation of pitch. If the membrane be uniform, of given density and given tension, the frequency of vibration is a function of the size and form; and if the form is invariable, the frequency varies as the linear dimension. The pitch of the vibrations of a regular polygon is intermediate between those of the inscribed and circumscribed circles. When the area of the membrane is given, it is easy to see that any projecting corners tend to raise the pitch, thus among rectangles of a given

area the square gives the gravest tone, and any membrane not a circle is higher in pitch than the circle of equal area. In estimating therefore the lower limit to the pitch of a regular polygon, it is best to substitute for it a circle of equal area.—*Proc. London Mathematical Society*, V., 9.

THE SPECTRA OF THE LEAST FUSIBLE METALS.

Messrs. Lockyer and Roberts have attempted to investigate the nature of the absorption spectra of the least fusible metals, for which purpose they employed the oxyhydrogen blowpipe to volatilize the substances. Their experiments, conducted at these high temperatures upon more than twenty metals, go far, they think, to support the conclusions which they had previously drawn from experiments at a lower temperature on more easily volatilized metals, viz., that in passing from a liquid to the most perfect gaseous state, vapors are composed of molecules of different orders of complexity, and that this complexity is diminished by the disassociating action of heat, each molecular simplification being marked by a distinct spectrum.

THE CAUSE OF THE VARIATION OF GASEOUS SPECTRA.

The variations in the spectra of gases have been usually supposed to depend to a certain extent upon the temperature at which the light is produced. Wüllner has advanced the theory that the spectrum depends upon the nature of the electric spark; but Goldstein has recently advanced opposite views, to the effect that the different order of spectra are entirely independent of the form of the electric discharge by which the light is produced. He states that he has been able to secure a notable increase in the width of the lines of the spectrum of hydrogen when the pressure has been less than one one-hundredth part of a millimeter. His experiments lead him to think that any given order of spectrum can be produced, if we only have a sufficiently high temperature.—19 *C*, VII., 444.

A SIMPLE SPECTROSCOPE FOR STARS.

For the purpose of observing the spectrum of stars or other points of light, Zöllner describes a very compendious instrument to be used in combination with the eye-piece of

a telescope. He introduces between the ordinary eye-piece and the eye of the observer a small tube containing a cylindrical convex lens of about four inches' focal length, for which lens, under different circumstances, we may substitute other lenses of different lengths of focus. Within the tube containing this lens, and between it and the eye, there is inserted a second tube holding an ordinary direct-vision prism, such as is made by Browning. The intensity of light in this ocular spectroscope is so considerable that in combination with a small portable telescope of one and a half inches' aperture it shows distinctly the lines of stars of the first magnitude, and of the crescent of Venus. It is peculiarly applicable to the systematic observation of star spectra in which the main object is to ascertain the typical constitution of the spectra.—7 *A*, XLVIII., 156.

THE BEGINNINGS OF SPECTRUM ANALYSIS.

According to Lockyer, the distinguished Swedish philosopher Angström, whose untimely death in June, 1874, was at the time chronicled by us, will be forever considered as the founder of spectrum analysis, although unfortunately the obstacles opposed by the language in which his first treatise was written, and by distance from the scenes of his investigations, for three years prevented even its existence from being known to the scientific world at large. His work, "Optiska Undersokningar," published at Stockholm in 1853, was the first publication in which use was made of a principle already propounded by Euler, viz., that the particles of a body in consequence of resonance absorb principally those æthereal undulating motions which are impressed upon them. He also endeavored to show that a body heated until it glows emits the same kind of light and heat which it absorbs under other circumstances; he further stated that in many cases the Fraunhofer lines are the inversion of the bright lines which are observed in the spectra of various metals in the galvanic arch.—12 *A*, X., 377.

SPECTRA OF CERTAIN RARER METALS.

Professor Thalen has published the result of an investigation into the spectra of the rarer metals yttrium, erbium, didymium, and lanthanium. He has operated with large

quantities of the metals of undoubted purity, and his results are the most reliable hitherto obtained. He has not only removed all doubt with regard to some 28 spectral lines that were hitherto known, but has increased the whole number of these lines peculiar to these metals from 160 to 590.

EFFECT OF TEMPERATURE AND PRESSURE ON THE SPECTRUM LINES.

The question has often been discussed whether it is temperature or pressure which causes the widening of the lines in the spectrum of any gas. The following considerations are adduced by Schuster as favoring the view that each separate molecule would show at all temperatures narrow lines only, but that the shocks of the other molecules cause the widening, which may therefore be considered as depending rather upon pressure than temperature. Frankland and Lockyer have found that if we increase the pressure of hydrogen while the electric current is passing through it, the lines begin to expand until the spectrum becomes continuous, and, finally, the current ceases to pass altogether. On the other hand, Gassiot has observed that if we diminish the pressure of hydrogen, its electric resistance diminishes, becomes a minimum, and then increases again. We are therefore compelled to accept Frankland and Lockyer's original conclusion that pressure and not heat is the cause of the widening of the line.—*Rep. Brit. Assoc.*, 1873, 39.

NEW TABLES OF SPECTRUM LINES.

The committee appointed by the British Association to construct a catalogue of spectral rays state in their recent report that the whole of their work is now finished and ready for the printer, so far as regards the solar spectrum, while the positions of the metallic lines, as determined by Thalen, have been only partly reduced to uniformity with the rest of the work. The tables presented by them are constructed by throwing the solar lines into those groups which catch the eye in observing the spectrum, and the position of each line has been corrected for the dispersion of air. Both Kirchhoff's and Angström's scales will be given with the adopted wave-lengths for each spectral line, so that it is hoped that, when these catalogues are printed, observers will find in them,

in a collected form, the best materials which yet exist for the identification of lines, and for the reduction of fresh determinations to wave-lengths.—*Rep. Brit. Assoc.*, 1873, 250.

ADVANTAGEOUS CONSTRUCTION OF THE SPECTROSCOPE.

In some remarks upon the optics of the spectroscope, Mr. Sorby states that in the construction of a spectroscope the eye-piece should be of as long a focus as possible, so as to cause all the rays to enter the eye. All magnifying beyond this means loss of brilliancy; and if the spectrum appears insufficiently large, an increase in the size of the collimating and telescope lenses, together with the prisms, or an increase in the number of prisms, should be made, until the spectrum appears large enough to suit the requirements of the observer.—12 *A*, X., 469.

ABBE'S REFRACTOMETER.

The new instrument devised lately by Professor E. Abbe, of Jena, for the determination of the index of refraction of any transparent body, has received high encomiums, and promises to be of use in all optical researches. In principle it is, we understand, based upon the property of total reflection of light. Two similar right-angled prisms are so fixed that their hypothenuses are parallel and a slight distance apart. Between them is placed the liquid to be examined, and by measuring the angle through which this combination must be turned in order to secure the total reflection of a ray of light, we have the means of directly determining the index of refraction. In order to employ white light, and annul the indistinctness caused by the dispersion of light, a compensator is introduced, based upon a combination of flint and ground-glass prisms, and it is stated by Professor Waltenhofer that the execution of measurements with this instrument leaves nothing to be desired as regards rapidity, elegance, and accuracy.—*Technische Blätter*, 1874, 106.

THE CAUSE OF THE LUMINOSITY AND NON-LUMINOSITY OF FLAMES.

It has been ascertained that if nitrogen, hydrochloric acid, or carbon dioxide be passed into the flame of a Bunsen burner, it becomes non-luminous; but when any such mixture

becomes strongly heated before it undergoes combustion it again becomes luminous.

From these observations it may be concluded that the non-luminosity of a gas flame is not caused by a dilution of the gas, this dilution being in fact increased by heating the mixture. The only cause is the cooling of the interior of the flame. This is further proved by the fact that it is most difficult to get a non-luminous flame from a mixture of coal-gas and oxygen, showing that neither rapid oxidation nor dilution produces the non-luminosity.—21 *A*, *July*, 603.

FLAME OF BURNING GLYCERINE.

According to Godeffroy, glycerine burns with a steady blue non-luminous flame, without diffusing any odor or leaving any residue.—17 *A*, *June* 1, 84.

A PERFECTLY MONOCHROMATIC SODIUM FLAME.

Laurent recommends the following simple method for rendering the light proceeding from a soda flame, which it is desired to use for saccharometric and similar work, perfectly monochromatic. Between the flame and the polarizer he interposes a thin lamina of potassium bichromate, which possesses the property of absorbing the violet, blue, and green rays contained in the sodium flame, the presence of which impairs the accuracy of observations involving a comparison or determination of the equality of tints.—2 *C*, III., 1875, 62.

AN APPARATUS FOR ILLUSTRATING THE MECHANICAL EFFECTS OF LIGHT.

Dr. William Crookes is the first to illustrate by experiment the production of direct mechanical effects by the action of luminous rays. The apparatus, with the aid of which the demonstration was made, and to which its designer gives the name of the radiometer, is described as follows: The radiometer consists of four small pith disks, fixed at the extremities of two crossed arms of straw, balanced on a pivot at the point where the straws intersect, so that they may freely spin round. These pith disks are white on one side and blackened with lampblack on the other, and the entire arrangement is inclosed in a glass bulb from which the air has

been removed with the help of a Sprengel pump. With an apparatus of this description, the disks and arms spun around rapidly when luminous rays were directed upon it, but obscure heat rays produced no effect upon it. When submitted to the action of light from which 95 per cent. of the heating rays had been cut out by the interposition of a plate of alum, the disks still revolved, though with somewhat diminished velocity. Contrary to expectation, it was the blackened faces of the disks that were repelled by the light.

THE SPECTROSCOPE WITH A FLUORESCENT OCULAR.

In observing the most refrangible portions of the spectrum it is common to use two methods—either the spectrum falls upon a plate sensitive to the ultra violet rays, or else the spectrum falls upon a fluorescent substance which has the property of revealing these rays. To this a third method is now added by Soret, whose application is very simple. Soret's method consists in this, that he inserts a plate of transparent fluorescent substance in the tube of the spectroscope, and observes the spectrum with a telescope whose ocular is inclined to its axis. With a plate of uranium glass the fluorescent spectrum is well seen. The best substance, however, is a somewhat concentrated solution of *aesculin*, by means of which the spectrum may be traced up to the line O. This simple apparatus affords an especially convenient method for examining the spectrum of the ultra violet portion of the solar light.—19 *C*, VII., 232.

ON THE INTENSITY OF THE LIGHT REFLECTED FROM GLASS.

Dr. Glau states that hitherto the investigations of the properties of reflected light have, by preference, referred to the ratio of the two principal components to each other, as well in respect to their phases as to their intensity; and in but few cases has it been attempted to make a direct comparison of these two components in regard to the incident light. The only experiments on the intensity are found in Arago's works, and are quite fragmentary, and on that account the inquiry has been undertaken anew by Dr. Glau, in order especially to test the accuracy of Cauchy's formula. His observations give the ratio of the intensity of the

reflected light to the incident light for two prisms, one of crown and one of flint glass. A comparison with Fresnel's formula, which is identical with Cauchy's, shows that the differences between observation and theory fall quite within the range of errors of observation.—7 *A*, XLVIII., 478.

THE FIXED STARS AS VISIBLE THROUGH MINUTE APERTURES.

In a recent letter to the English *Mechanic*, Mr. Allen endeavors to contribute somewhat to the understanding of the phenomena of the black drop, by considering the question of the visibility of the stars through minute apertures. He states that the stars are not seen ordinarily on a clear night as simply intensely bright and vivid spots on a dark background without rays or bright surrounding burrs, but generally accompanied by three or four or more rays darting out of the bright burr. The question as to whether these phenomena are caused by interference or by the atmosphere, or whether they are purely subjective, can perhaps be decided by viewing the stars through minute needle-point holes in a thin opaque plate. If through such a minute hole we look at a dull, white, cloudy sky, we see not only the dull hue of the sky, but also a thin, gauze-like covering as of lace hanging between the opaque plate and the sky. When the hole is comparatively large the edges of the field of view only are covered by this gauze veil, while when the hole is exceedingly small the effect is intensified by the closing in of the veil on all sides, so that the field of view is completely filled up with an almost black gauze which can only be seen through darkly. On viewing the stars through such a minute hole, it will be found that the rays ordinarily darting from the star totally disappear, not only the longer rays, but also the shorter ones forming the bright burr, and the star appears like a planet, showing a clearly defined disk with a somewhat fainter light, in the centre of which a minute black point is distinguished. Viewed in this way the star still twinkles, and has still the color and the changes of color as ordinarily seen. If now two needle-holes be made near together, perhaps $\frac{3}{16}$ of an inch apart, then the two images of the star will be seen apparently touching each other, with a black spot at their point of tangency.—18 *A*, XX., 5.

THE OPACITY OF PHOTOGRAPHIC IMAGES.

In a series of pictures of the sun which have lately been taken by photography, Captain Abney states that he finds the opacity of the image by no means to vary directly as the time of exposure. Having obtained a standard gradation of intensity of light by causing a starlike aperture to revolve rapidly around its centre, he determined the relative opacities of the images by comparison with smoke-colored glass wedges, and he finds that the degree of opacity after diminishing very rapidly in the first moments of exposure, then diminishes very much slower, and nearly proportional to the time. The images given on dry places are in general somewhat more opaque than those given by weighty plates, especially during the first moment of the exposure.—7 *A*, XLVIII., 164.

ON WAVE SURFACES IN OPTICS.

Cellérier has in a note on the optical properties of elastic media shown in brief that there is no discord between the laws of double refraction as furnished by observation and by theories based upon molecular movements. It is probable that the ordinary ray, either in the crystals of one axis or in the principal sections of the crystals of two axes, has not always the direction that is ordinarily assigned to it. This deviation, however, without being discordant from theory, may be so small as to escape observation. Finally, renouncing all mechanical explanation of the phenomena, it is necessary to admit that the direction of the vibrations is parallel to the plane of polarization, and therein is a decided confirmation of the theory. There is, in fact, at present not any other new hypothesis necessary in order to show the coincidence between theory and observation.—*Biblioth. Univers., January*, 1874, 23.

ELLIPTIC POLARIZATIONS OF LIGHT.

The nature of the light reflected by potassium permanganate has been investigated by Dr. Wiedemann, who has examined the reflected light both by the spectroscope and the polariscope. The crystals of the above-mentioned substance were polished upon ground-glass plates, thus giving clean

surfaces free from oxides. The positions of the lines in the spectrum were determined by reference to a photographed scale, and it was found that with large angles of incidence the lines in light polarized perpendicular to the plane of incidence were displaced toward the blue end of the spectrum, as compared with those lines that occur in light polarized parallel to the plane of incidence. Again, in the former light a new line occurs in the vicinity of the line D. With an increase in the index of refraction of the surrounding medium, the lines in the parallel polarized light undergo displacement toward the blue, while those in the perpendicular polarized light alter their positions but very little. In the light polarized parallel to the plane of incidence, as also in natural light, the positions of the lines did not vary with the angle of incidence, while they do vary in perpendicularly polarized light.—7 *A*, XLVIII., 232.

A NEW CLASS OF ABSORPTION PHENOMENA.

A late number of the memoirs of the Spectroscopic Society of Italy contains a contribution by Lockyer to the spectroscopic investigation of the absorption phenomena. These phenomena consist in observing the absorption produced by vapors of sodium and potassium heated in a red-hot tube through which a beam of sunlight passes. Lockyer states that the Fraunhofer line D becomes broader on one side; and again, in reference to the general question of the absorption of great thicknesses of metallic vapors, he states that metallic elements of low specific gravity give spectra approaching in their appearance a continuous spectrum by increasing the number of their lines.—*Memoirs of the Italian Spectroscopic Society*, 1874, 97.

THE PHOSPHORESCENCE OF PHOSPHORUS.

From the doctorate dissertation of Joubert, of Paris, we gather that he has definitely settled the question as to the origin of the phosphorescent light of phosphorus by demonstrating that it is really due entirely and only to the slow oxidation of that substance. Among the numerous results of his unusually thorough and suggestive work, we note that in pure oxygen the temperature at which phosphorescence takes place depends on the pressure of the gas; and in di-

luted oxygen the law is quite different. The elastic force of the vapor of phosphorus is 0.5 millimeters at a temperature of 5° Centigrade, but is 6.8 millimeters at a temperature of 40° Centigrade. In absolute vacuum, or in pure inert gases, no phosphorescence takes place.—8 *B*, *July* 25, 1874, 87.

ON OPTICAL PHENOMENA AT THE TRANSIT OF VENUS.

Mouchez states in reference to the observations of the black drop, as it appeared to the French observers at the island of Saint Paul in the Southern Pacific Ocean, that in proportion as Venus entered upon the sun's disk the clouds became thinner, the heavens more transparent, and images of great precision. A quarter of an hour after the first contact, while half of the planet was still beyond the limit of the sun, suddenly the whole disk of Venus was perceived shining like a pale circle, more brilliant in the neighborhood of the centre than at the outer edges of the planet. The diameter of the planet was immediately measured with the micrometer, and found to be identical in all directions through its centre, showing that the disk was real, and not an optical deception. But in proportion as the second contact approached the two brighter portions in the neighborhood of the centre tended to unite themselves into an enveloping circle of bright light around the segment of the planet which was still exterior to the sun. And this anticipated reunion of the horns by a luminous circular arc was rendered more complete still by a small, very brilliant flange of light terminating the aureole on the disk of Venus. Foreseeing that there would be very great difficulty, if not impossibility, in observing the geometrical second contact, the observer changed quickly the pale blue colored glass for a darker one, by the aid of which he hoped to avoid this aureole, and these accidental glimmerings. But this was useless; the aureole remained always visible, and he was obliged to return to the original lighter-colored glass. Under these conditions, he took as the moment of contact, not the reunion of the two horns or the geometrical contact, but rather the moment when the disk of the sun seemed no longer to be deformed by the brilliant light which enveloped the planet at the point of contact. He noted a very sensible difference of

time between the instant when he thought that this contact had taken place, and that when he was certain that it was past.—*Bulletin Hebdomadaire*, XVI., 21.

ON THE PHENOMENA OF DIFFRACTION PRODUCED BY CIRCULAR NET-WORK.

Soret states that he gives the name of circular net-work to opaque screens pierced by a series of apertures presenting the form of concentric rings. When a beam of light falls upon such a net-work, phenomena of diffraction are produced varying according to the relations which exist between the diameters and the breadths of the rings. Some very remarkable phenomena have been observed by him, which seem to verify the theoretical considerations that he has advanced in reference to this subject. The screens experimented upon by himself were obtained by making a design in china ink in the form of 196 concentric circles, whose radii were proportional to the square roots of the natural numbers 1, 2, 3, etc. The first circle had a radius of 25 millimeters. The greatest, consequently, had a radius of 350 millimeters. The rings comprised between the first and second, between the third and fourth, etc., were blackened. We thus have in white upon black background the figure of a grand positive circular net-work, having 96 concentric rings. This design was reproduced by photography upon glass, in various scales of from one one-hundredth to one twenty-fifth of the size of the original. A beam of solar light is now introduced into a dark chamber by an opening of any form whatever, and we place a red glass before this opening, thus giving nearly homogeneous light. Then at a proper distance a collimating lens, which renders the rays parallel, and gives at a great distance at the end of a large hall an enlarged image of the opening. Behind the collimating lens we place the circular net-work formed as previously described, the image at the end of the hall continues, only it is a little less clear, and is surrounded by an aureole, which we may attribute to the imperfection of the net-work. If now we place a white screen at the proper distance, we shall obtain a new image of the opening, smaller but distinct. But outside of this image the screen is also illuminated, as it should be, to accord with the theory. Bringing the screen into the second proper position, we observe a

still smaller image, scarcely visible, in fact, with the one twenty-fifth screen in which the proportion of light and darkness is well marked, being better marked with the finer screens. In the intermediate distances we have upon our screen no image, but simply a luminous spot. If we repeat this experiment with white light, we find the circular net acting like a non-achromatic and very dispersive lens. At the distance proper for the red rays, the image is red, surrounded by a blue aureole. On removing the screen further, the image changes through the yellow and the green, and finally becomes blue; having in the latter case a red aureole. From this latter experiment Soret shows that we can consider the little circular screens as concave lenses, so that the ordinary Galilean telescope may be constructed by employing such a screen instead of the eye-glass.—*Bull. Hebdom.*, XVI., 71.

THE COLOR OF DIAMONDS.

Flight and Maskelyne have lately made some curious observations upon colored diamonds. It has for some time been known that the tints of these stones are either destroyed or modified by heating, the change being sometimes temporary, sometimes permanent. In the present case two yellowish diamonds from the Cape of Good Hope were strongly heated in an atmosphere of hydrogen in a porcelain tube, for about two hours. Upon cooling, the color of the stones was found to have vanished, but it returned after exposure, for only a few minutes, to diffused light. In one instance a diamond which had been decolorized by heat was kept in the dark for three days, and remained colorless; but an exposure of six or seven minutes to the light again brought back its yellowish hue. These facts appear to stand in some relation to phenomena of phosphorescence.—15 *C*, XXIX., 33.

GILT GLASS PRISM IN THE CONSTRUCTION OF THE CAMERA-LUCIDA.

By taking advantage of the property possessed by thin metallic films of allowing the passage of direct rays through them, while they reflect oblique rays from some other source, Professor Govi, of Rome, has devised a perfect method for superposing a direct and reflected image, as is necessary in the camera-lucida, without the usual fatigue to the eye. He

simply gilds the reflecting surface of the prism, in the camera-lucida, with a very thin film of gold, and, with Canada balsam, cements to this surface another similar prism. The reflected image appears of the usual yellow color of gold by reflected light, while the transmitted one is green, a difference that is not only not annoying, but in some cases serviceable. The suggestion of Professor Govi has been adopted by Nachet in the construction of various forms of camera-lucida.—14 *C*, CCXIII., 1874, 447.

COMPRESSIBILITY OF WATER.

Mascart has shown that the compressibility of water varies more rapidly than the pressure, as has already been observed for other liquids. The methods used by him to investigate the subject have also induced him to measure the heat evolved by the compression of water; or, rather, the lowering of temperature when the pressure is suddenly removed.—4 *D*, VII., 593.

NEW PHOTOMETERS.

Major Elliot reports that in his visit to the establishment of Messrs. Chance, at Birmingham, the scientific director in charge, Dr. Hopkinson, presented him with a photometer of his own invention for the comparison of lights at a distance. It is very compact, and consists of two Nicol prisms which can be moved relatively to each other in azimuth. A little tube carries the analyzing prism, and a second tube contains the polarizing prism. The latter being turned until the observed light is just diminished to the point of invisibility, and another light being then observed in the same way, a comparison of the angles gives the relations of the powers of the lights. The French Light-house Commission employ a photometer different from Bunsen's, as ordinarily used in America, in which, instead of keeping both the standard light and the one under test fixed in position, the former is moved until the beams from both, after passing through a slit or opening in the photometer, fall upon a pane of glass which has a ground surface, and which, as viewed on the reverse side, seems equally illuminated by the two lights. The distances from the photometer are then measured by a tape line, and reference to a calculated table shows at once the

intensity of the light under test, in terms of the standard, or unit, which in France is always the Carcel burner, consuming forty grammes of colza oil. This French unit is estimated to be equal to between nine and a half and eleven and a half of the English units or candles.—*Elliot's European Lighthouse System*, p. 183.

THE REFLECTION OF LIGHT.

An almost exhaustive historical essay, by Lundquist, on the investigations of earlier physicists into the peculiarities of the light reflected from the surfaces of solid bodies, is supplemented by observations made by himself on the reflection from fuchsin and some other substances. The methods followed by him were similar to those adopted of late years by Jamin, Wiedemann, Van der Willigen, and others. A narrow pencil of sunlight, reflected in a fixed horizontal direction from a heliostat, passes successively through an achromatic lens, a flint-glass prism, and a polarizing Nicol's prism, and falls upon the reflecting surface of fuchsin; the reflected light is then analyzed by a compensator and a second Nicol's prism. Rays of light from seven different portions of the spectrum were examined; and Lundquist concludes that, in respect to the principal angle of incidence, fuchsin comports itself as does indigo, and the observations are represented by the theoretical formulæ for metallic reflection so long as the angle of incidence is greater than 50°. The author's investigation into the intensity of the reflected light shows that, on the one hand, the intensity is always slightly less than that computed, and that, on the other hand, the quantities reflected vary sensibly with the color of the incident light, so that when white light falls upon the fuchsin the color of the reflected rays varies with the angle of incidence. The power of the substance to absorb different colored rays offers a remarkable anomaly, as, while the yellow light is reflected in greater proportion than the blue, it is absorbed in less proportion.—*Poggendorff Annalen*, CLII., 595.

THE ACTION OF LIGHT UPON CHLOROPHYLL.

It has been long known that alcoholic extracts of chlorophyll are decomposed rapidly in the sunlight, but slowly in diffused daylight, and in even the faintest light assume vari-

ous colors. The presence of oxygen is necessary, according to Wiesner, in order that the rays of light may effect the decomposition of chlorophyll, and this author has made an interesting investigation into the action of different portions of the spectrum. He concludes that all the chemical changes caused in chlorophyll cells by the rays of light (namely, their development, decomposition, and assimilation of other substances) take place most rapidly in the brightest portion of the spectrum; and that, while all portions of the visible spectrum have the power of inducing these changes, the mechanical effects of light upon plants are to be especially ascribed to the rays of high refrangibility.—*Poggendorff Annalen*, CLII., 503.

EXPERIMENTS ON THE VELOCITY OF LIGHT.

While astronomy has been busy with the problem of the sun's distance, physics has contributed an independent solution to this question. M. Cornu, of the French Academy of Sciences, has repeated the celebrated experiments on the velocity of light which were proposed by Foucault and Fizeau some twenty-five years ago. He has himself improved the method of Fizeau, and his experiments were exhaustively conducted and have been perfectly successful.

M. Cornu chose for his two stations the Observatory of Paris and the tower of Montlhéry, whose distance apart (about fifteen miles) is very precisely known. The beam of light passing from the observatory fell upon a toothed wheel revolving no less than 1600 times per second; a portion of the beam, escaping through the interval between two teeth, passed on to a reflector at Montlhéry, and returned thence to the revolving wheel. If the rotation of the wheel during the time required for the light to travel to and fro over twice the distance between the two stations interposes a tooth in the path of the returning ray, an extinction of the luminous impression occurs, and from the known velocity of rotation of the wheel, and from the known distance of the stations, the velocity of light can be had. By revolving the wheel at different rates this extinction can be made to occur at the fourth, fifth, sixth, etc., tooth. A great accordance characterizes Cornu's results, and high importance attaches to this delicate research. All the observations were made at

night by the aid of a Drummond light, except one which was made by sunlight. Exceptionally still weather was chosen for each experiment. From these observations there results a velocity for light *in vacuo* of 300,400 kilometers per second (186,700 English miles), with a probable error of less than $\frac{1}{1000}$ of the whole amount. The solar parallax is directly deducible from Cornu's velocity of light in two ways. Thus, combining it with Delambre's value for the *equation of light*, we find a solar parallax of 8.88″, while Bradley's value of the *aberration of light* gives a parallax of 8.88″, and Struve's value of the *aberration* constant gives 8.80″. M. Cornu in his elegant memoir gives a summary of the values of the sun's parallax as deduced by various methods. The harmony of the results is marvelous when we consider with how minute a quantity we are dealing. The eight values that may be thus deduced range between 8.80″ and 8.88″; and it is possible that the transit of Venus may not give a much better determination.

AUTOMATIC REGISTRATION OF THE CHEMICAL ACTION OF LIGHT.

The measurement of the chemical intensity of the solar light has not yet become a subject of regular meteorological observation, because of the want of a proper instrument. This want is now partly supplied by a method proposed by Roscoe, who proposes to effect the measurement by the blackening of a paper saturated with chloride of silver; or, rather, by means of the time required in order that the exposure to the light may bring about a given intensity of shade. A uniformly prepared paper is placed in the apparatus during the previous night, and is, by a mechanical arrangement, hourly exposed during a given interval to the sunlight. In order to estimate correctly the intensity of the solar action, Roscoe arranges the apparatus so that the paper shall, each hour, many times in quick succession, be exposed to the light for from two to thirty seconds. We thus have, at each hour of the day, a complete series of small spots of various tints, and have only to seek that tint which corresponds to the normal to know at once the number of seconds of exposure corresponding to the strength of the sunlight at that time. A series of observations made during the months of May,

June, and July have given very accordant results in the hands of Roscoe.—19 *C*, VII., 202.

NEW METHOD OF MEASURING THE VELOCITY OF LIGHT.

A simple and possibly accurate method of measuring the velocity of light is suggested by Mr. Burgue. A disk, turning very rapidly about its axis, is at each turn to be illuminated by an intermittent and instantaneous light. A single dark radial line on the disk will seem at rest, like the disk itself. Now withdraw the source of light to a distance, and the time the light takes to reach and illuminate the disk will become greater, and the position of the radial line will appear displaced to a new position, forming with its previous position a certain small angle, which will measure the time of the light's passage over a given distance.—1 *A*, II., 262.

GREAT FRENCH LIGHT-HOUSE AT LA HAVE.

The great French light-house at La Have, near Havre, is said to be the most magnificent establishment of its kind in the world. The electric light was first used at this place in 1863. The electricity is furnished by magneto-electric machines, and the simple uncondensed beam of light is equal to 4000 candles, and it seems to be the testimony of navigators that this electric light is always seen, even in clear weather, before the oil lamps nearer them. Its range of visibility is also correspondingly greater, the radius of the circle lighted up being from five to ten miles greater than that of first-class oil lamps. The difference between the two is, in fact, similar to the comparison of a candle and a gas-light. At some distance there is also a notable difference in their aspects, the electric light appearing white and brilliant, the other red and smoky. The superiority of the former is still more manifest during foggy weather, since at such times, even before perceiving the electric light, its presence is marked by the illumination of the thick atmosphere surrounding it, and its range thus increased. This is an important advantage of the electric light, and may be of great practical utility, as has, in reality, frequently been the case. While its brilliancy gives it this superiority, its inferior power of penetration diminishes the range of the electric

light in foggy weather, and more notably as the fog thickens. In general, it is found that if the electric light has an intensity two and a half times greater than the oil-light, it will penetrate fog as well as the latter. The expense of the powerful electric light at La Have is about one seventh greater than that of the decidedly inferior oil-lights. General testimony seems to be in favor of the introduction of the magneto-electric light at all important stations, and both the English and French are extending its application.—*Elliot's European Light-house System*, p. 248.

THE ROMAN PHAROS IN DOVER CASTLE.

There is still standing within the walls of the castle at Dover, England, an old Roman pharos. The antiquity of this light-house, which has probably not been used as such since the Norman conquest, no doubt exceeds that of any light-house in Great Britain, it having been built, as is supposed, about A.D. 44. Upon it burned for many centuries great fires of wood or coal, the modern system of lamps and reflectors having superseded coal fires during the last century. This pharos, like the one at Boulogne, is built of bricks in color and shape like those found elsewhere in the Roman structures of Great Britain. They are of a light red color, about fourteen inches long, and not more than an inch and a half thick. The mortar joints are of nearly the same thickness. The preservation of this famous relic is doubtless due to the fact that some centuries ago the tower was turned into a belfry, and was surrounded by walls of stone. The latter are now nearly destroyed by time, and the old remaining work is again exposed.—*Elliot's European Light-house System*, p. 73.

THE POWER OF THE ELECTRIC LIGHT.

The most powerful artificial light at present in existence is that employed for the great light-house at Souter Point, on the coast of England, near the mouth of the Tyne.

On both banks of this river there is an immense number of manufactories of all kinds, the smoke from which, under the influence of the west wind, seriously obstructs the approaches from the sea. Fogs at this part of the coast are also frequent; and the problem of light-house illumination

required that such light should be secured as would penetrate through any slight fog or haze, it having been generally acknowledged that not even the sunlight itself can penetrate an ordinary dense fog. The electric light established at Souter Point after condensation is equal in power to 800,000 standard candles, being eight times as powerful as the best American fixed lights. The electric spark passes between slender pencils of carbon, which are themselves consumed at the rate of about one inch per hour. The electric current is generated by two of Professor Holmes's patent rotary magneto-electric machines, driven by steam-engines of six horse-power. The number of revolutions made by each machine is 400 per minute, and 12,800 sparks pass per minute when both machines are at work. These sparks are, of course, formed so rapidly that the eye does not separate them, and the result is an intense beam of light, so dazzling that the eye of a person within the lantern can not rest upon them for an instant without intense pain. As observed from a distance of several miles, this light is so bright as to cast a well-defined shadow upon the deck of a vessel.—*Elliot's European Light-house System*, p. 120.

ELECTRIC LIGHT FOR LOCOMOTIVES.

A series of satisfactory experiments has lately been made in Russia in regard to lighting railway tracks from the locomotives by means of the electric light. The track on one occasion, with a battery of forty-eight cells, was brilliantly illuminated 492 yards ahead.—23 *A*, *April* 9, 1875, 467.

THE BLACK-BULB-IN-VACUUM THERMOMETER.

As is well known, the black-bulb-vacuum thermometers employed for observing the solar radiation give very discordant results, even in the hands of the best observers, and the origin of this has recently been studied by Mr. Hicks, of London, who states that in his opinion the discordances are in a great measure due to the imperfect vacuum that exists within the inclosing bulb. Having made a large number of thermometers with special care, in which the vacuum has been reduced to the lowest attainable limit, Mr. Hicks finds that it is possible with proper care to always construct instruments that shall be perfectly comparable with each

other. In order that the meteorologist may at any time test the perfection of the vacuum within his tube, Mr. Hicks has very ingeniously inserted two wires into the sides of the bulb in such a way that a galvanic current applied to the wires will, by the nature of the light that is spread through the vacuum bulb, show with considerable accuracy what proportion of gas, and especially of watery vapor, is there present. A pressure within the vacuum bulb exceeding one tenth of an inch of mercury is not admissible if an accurate instrument is desired, and the vacuum can be easily brought to within one fiftieth of an inch, in which condition the radiation solar thermometers will prove strictly comparable. Especially is it important that the bulb should be filled with dry gas, and that not the slightest trace of moisture should exist. Mr. Hicks said that, although he had made hundreds of tubes with Torricellian vacua, he never knew one to fail showing stratification and white light when the tube was thoroughly clean and free from moisture.—*Quar. Jour. Meteor. Soc.*, II., *April*, 1874.

THE THERMAL CONDUCTIVITY OF MERCURY.

Herwig has been continuing the inquiry previously instituted as to whether the thermal conductivity of mercury varies with the temperature—a question of much moment in connection with the reliability of the indications of the mercurial thermometer at different temperatures. He finds that between 40° and 160° Centigrade the heat-conducting power of pure mercury is perfectly constant. He is now occupied in a series of experiments to show how far solid metals differ in their behavior from mercury.—13 *A*, *Feb.* 27, 1875, 222.

A NEW SOURCE OF ERROR WITH THE MERCURIAL THERMOMETER.

Mr. J. M. Morgan, in employing a mercurial thermometer in the operation of distillation, the instrument being inserted into the apparatus to such a depth that the whole of the quicksilver thread was surrounded by heated vapors, observed after the operation had continued for several days that the temperature registered was too low by 3°. An examination showed that this error was due to the fact that a portion of the mercury had vaporized and condensed in

the upper part of the tube which was not exposed to the heat of the operation. When the portion condensed in the upper end of the tube was united, by cautious tapping, with the main column, the instrument again registered correctly. The observer of this phenomenon determined thereupon by experiment that a quantity of mercury corresponding to from 1° to 15° will be volatilized in the manner described if the mercury column of a thermometer is exposed for several days to a temperature of from 60° to 100° Centigrade. This observation is worthy of the special attention of experimenters, since the small quantity of mercury thus condensed in the upper end of the thermometer tube may be readily overlooked, and thus give rise to serious errors of observation.—*Fresenius's Zeitsch. für Analyt. Chem.*, XIV., 81.

RELIABILITY OF SIEMENS'S PYROMETER.

The Siemens pyrometer has been subject to a careful investigation by a committee of the British Association, in order to decide whether or not the resistance is altered after exposure to high temperatures. Four instruments were examined, three of which were found to be considerably altered after having been exposed to a high temperature; the fourth gave results showing it to be sufficient for industrial application, if not for strictly scientific observations.—12 *A*, X., 373.

A NEW MERCURIAL MINIMUM AND MAXIMUM THERMOMETER.

Mr. Denton describes a maximum and minimum thermometer combined in one, by which both registrations of temperature are obtained from one mercurial bulb, both indices are moved by the mercury pressing on their ends, and, independent of the self-registering feature, the actual temperature is shown, at any moment, by two separate columns of mercury. In the construction of the instrument the tube of the maximum thermometer is bent at the top and turned downward, and dips into an hermetically sealed chamber, which is itself more than half filled with mercury. An increase of temperature raises the index of the maximum thermometer and pushes down the mercury in the other leg of the tube. A diminution of temperature leaves the maximum index in its place, and allows the mercury in the other leg

of the tube to rise, pushing up with it its index, which is, in its turn, left in its place where the maximum thermometer has passed. The graduations of the second or minimum stem of the thermometer are counted downward, and those of the maximum stem are counted upward. As constructed by Casella, it is said this instrument is extremely sensitive, convenient, and reliable.—*Quar. Jour. Meteor. Soc. of London*, 1875, II., 193.

NEW SELF-RECORDING THERMOMETER.

In constructing a thermometer in which the dilatation of the metal shall give the measure of the temperature of the air, Tremeschini states that he has endeavored to eliminate the inconvenience peculiar to the nature of glass by making use of a metallic band as an indicator of the temperature. In his thermometer, which he exhibited lately to the French Meteorological Society, he employs a band of copper slightly platinized in order to preserve it from oxidation. This band is nine centimeters long and seven millimeters broad, and has a thickness of one twentieth of a millimeter, and is therefore extremely sensitive to atmospheric temperature changes: it is coiled about a central axis, very much like the hair-spring of a watch, and is contained within a case similar to that of an ordinary aneroid barometer. The temperature is read on the face of the thermometer by an index, which may even describe an entire circle in passing from $-40°$ to $+100°$ Fahrenheit.—*Nouv. Meteor.*, 1875, 14.

ON THE EXPANSION OF INDIA RUBBER BY HEAT.

According to the studies of Schmulewitsch, based in part on the studies of Puschl and Exner, as well as his own experiments, the somewhat anomalous behavior of caoutchouc under the influence of heat may be expressed by the following four propositions: First, caoutchouc is a body whose density is a minimum at a certain temperature. Second, this minimum temperature changes with the mechanical extension, being lower the more the body is extended by the application of some external force. Third, in the case of caoutchouc unexposed to any strain, the temperature of the minimum density is higher than ordinary temperatures, but approaches the latter by heating; its co-efficient of expan-

sion is positive, but diminishes with increasing temperature. Fourth, in the case of strongly extended caoutchouc, the temperature at which its density is a minimum is lower than ordinary temperatures; its co-efficient of expansion is therefore negative at the latter temperature, and increases numerically with the temperature.—19 *C*, VIII., 146.

ON THE MOLECULAR HEATS OF SIMILAR COMPOUNDS.

Professor F. W. Clarke states that as the result of an extensive comparison between the molecular heats of similar compounds, he finds that these have equal values, not at the same temperature, but at what are called corresponding temperatures, which are at equal or nearly equal distances from the respective melting points.—*Bull. Phil. Soc. Washington, June*, 1874.

ON THE REPULSION DUE TO HEAT.

In his reply to the criticism of Professor Reynolds, Professor Crookes states that abundant observations which have been accumulated by him during some years appear in every way to contradict the theory that the phenomena observed by him are due either to air-currents existing within vacuum tubes or to electrical phenomena. As to the theory of Professor Reynolds, that the effects are the results of evaporation and condensation, he satisfactorily shows that while this explanation might sometimes be admissible, yet in general it requires the adoption of assumptions that seem to be wholly at variance with the facts. He concludes by stating his belief that the repulsion observed by him as accompanying the radiation of heat and light is directly due to the impact of the waves upon the surface of the moving mass, and is not a secondary effect through the intervention of air-currents, or electricity, condensation, etc. Whether the æthereal waves actually strike the object moved, or whether at the boundary of the surface, solid or gaseous, there are intermediate layers of condensed gas which, taking up the blow, pass it on to the layer beneath, are problems the solution of which must be left to further research; and, without insisting upon any theory of his own, he proposes it merely as a useful working hypothesis. Any theory will account for some facts, but only the true explanation will satisfy all

the conditions of the problem, and this can not be said of either of the theories which have thus far been discussed. To quote the eloquent language of Sir Humphrey Davy, "When I consider the variety of theories which may be formed on the basis of one or two facts, I am convinced it is the business of the true philosopher to avoid them altogether. It is more laborious to accumulate facts than to reason concerning them; but one good experiment is of more value than the ingenuity of a brain like Newton's."—7 *A*, XLVIII, 94.

THE SPECIFIC HEAT AND CUBIC EXPANSION OF BODIES.

Mr. Walter Spring communicates to the Royal Academy of Belgium the following note with reference to the specific heat of bodies. He states that he sought to determine whether there were any relation between the specific heats and the co-efficients of cubic expansion by heat. He arrives at very beautiful results, both practically and theoretically. For instance, the computations which he makes of the specific heats of mercury and of graphite agree to the fourth decimal place with the observations of Regnault, Dulong, and Petit. He concludes that the product obtained by multiplying the specific heat of any body by its atomic weight can not be constant, since the specific heat is itself a function of a variable factor.—*Bulletin of the Royal Academy of Belgium*, 1874, 294.

LIGHTNING-CONDUCTORS.

In a few remarks upon the action of lightning-conductors, Secchi, the well-known astronomer, describes the storm of November, 1872, in which the cathedral and palace of Alatri were struck by lightning, these structures having been free from such visitations for many years. The damage done on this occasion was, as he shows, due in great measure to the fact that the lightning-rods, instead of being directly connected with the metallic gutters and other portions of the roof, were isolated from them. The fluid, therefore, sought to make its own way to such other good conductors as were near. After quoting other instances, he expressed the opinion that the conditions most favorable to safety consist in joining the lightning-rod directly to all the metallic portions

of the roof, and especially to the rain-water pipes, in order that greater facility may be offered to the electric fluid in its passage to the earth.—*American Engineer*, I., 122.

ATMOSPHERIC ELECTRICITY IN SPITZBERGEN.

In reference to the observations of atmospheric electricity in high northern latitudes, in which, as yet, our instruments have generally given negative results, Wijkander states that the late Swedish polar expedition gave special attention to this subject, and that all their observations show that at relatively high temperatures the air conducts electricity very well, to which fact is ascribed the absence of lightning and the presence of the Northern Lights. It has been said that these latter phenomena depend upon the great moisture of the air in these regions; but it seems clear that the polar light is conditioned by other circumstances, since the same temperature and the same degree of humidity do not bring forth these results in other latitudes.—19 *C*, VII., 422.

VELOCITY OF THE TRANSMISSION OF ELECTRIC FORCE.

The question as to whether electric and magnetic forces require sensible time to exert their influence, at a distance, has been made the subject of numerous investigations, one of the most interesting of which is that of Herwig, who has endeavored to conduct experiments upon as large a scale as possible. The preliminary results to which he was led have, he thinks, justified him in formulating the conclusion that if the terrestrial magnetic influence has any definite velocity of transmission whatever, it must be at least at the rate of half a million of miles per second; and that the influence of the earth's magnetism at any point of the earth's surface attains its full degree within $\frac{1}{300}$ of a second.—19 *C*, VIII., 30.

EDLUND'S THEORY OF THE NATURE OF ELECTRICITY.

In a report on the theory lately advanced by Professor Edlund as to the nature of electricity, Dr. Emsmann states that apparently Edlund has, in this matter, taken such a step forward as was made when previous investigators were able, by means of one æther, to explain both optical and thermal

phenomena. Edlund's theory consists essentially in ascribing to the æther itself an inertia which necessitates a slight interval of time in order to affect its movement. The flow of æther from one body to another explains the electro-dynamic phenomena, while its abundance or deficiency in any body serves to explain the electro-static phenomena. As regards the chemical influence of the galvanic current, it is assumed that the electricity has an equal influence upon the bodies that are to be separated or combined by it. The rotation of the plane of polarization of light is elucidated by the simple assumption that the electric æther is not different from the optical æther, and it must be acknowledged that Edlund's theory is based upon well-known facts, and is distinguished by its simplicity and sufficiency.—7 *C*, X., 402.

ON THE ELECTRICITY OF MINERAL WATERS.

Professor Theury, of Geneva, and Dr. Minnich have conducted some remarkable experiments in reference to the electrified condition of the mineral waters of certain springs, respecting one of which, the Stadthof, near Baden, in Switzerland, they state that their experiments show that the warm water at its escape from the soil is quite strongly electrified, it being negatively electrified with reference to the electric current at the thermal spring at Limmat. The currents observed by them are not the result of any thermo-electric action, nor are they the result of any special electric chemical action between the carbonic acid gas and the platinum electrode, but appear to them to be peculiar to the spring-water itself.—13 *B*, III., 186.

THE STRATIFICATION OF ELECTRIC DISCHARGES IN VACUO.

Messrs. De la Rue, Miller, and Spottiswoode have conducted a long series of investigations looking to the ascertainment of the cause of the stratification of electrical discharges in vacuo. Without bringing their investigations to a close, or pointing out any conclusions as distinctly reached, it is evident from their experiments that the stratification is due to a peculiarity in the flow of the electricity, which flow is apparently of the nature of an intermittent discharge, whose periodical overflows, so to speak, take place at very short intervals, and whenever the current acquires strength enough to over-

come the resistance offered by the rarefied medium through which it must flow.

EARTH-CURRENTS ON TELEGRAPHIC LINES.

The Asiatic Society of Bengal, in consideration of the important labors of Mr. Schwendler, has taken steps to influence the government of India to especially investigate the subject of earth-currents on telegraph lines—a work which ought, in the interest both of science and art, to be taken up not only by the European governmental, but by American private telegraph companies.

ON UNILATERAL CONDUCTIVITY OF ELECTRICITY.

While engaged in other work, Dr. Schuster states that he met with an irregularity which seemed to be of such a peculiar nature that he subjected it to a separate investigation; although he is not yet able to raise this phenomenon above the rank of an irregularity, yet his experiments leave no doubt as to the fact. It seems to him clear that the current produced by an electro-motive force in a circuit composed entirely of copper wires, joined together by means of binding screens, may under certain circumstances be different from the current produced by the same electro-motive force acting in an opposite direction. He calls this phenomenon "Unilateral Conductivity." The most plausible explanation seems to him to be that a thin layer of air may sometimes intervene between the two wires that are screwed together, an explanation that has been confirmed by some experiments, while others show that it is insufficient.—7 *A*, XLVIII, 246.

THE ELECTRIC CHARGE OF A CONDUCTING WIRE.

The researches of various physicists have proved that an electric current, before it can circulate in any conductor, must charge it electrically, and consequently in the entrance of a current into the circuit two periods are distinguished. In the first the wire is charged, the current passing through a variable state until it gradually acquires its normal value. In the second period the current has become constant, and its value depends on the conditions determined by Ohm's law. According to Villari, the first or variable state has no constant duration; it increases with the length and condition

of the circuit, and also with the so-called co-efficient of charge of the wire, which co-efficient is measured by the quantity of electricity necessary to give a unit's charge to a unit's length of wire. This co-efficient of charge varies with every metal, and with it varies the duration of the current's variable state; the quantity of electricity which the current consumes to establish itself is with the different metals also variable.—18 *A*, XX., 4.

THE ACTION OF ELECTRICITY ON PHOSPHORUS.

In 1860 Dr. Giessler endeavored to show that electricity of itself can effect the conversion of ordinary phosphorus into amorphous phosphorus. An apparatus recently devised by Schwendler shows that the conversion of the phosphorus is effected even by the inducing action of the current of electricity. For this purpose the ends of two conducting wires are inserted into exhausted spheres in which there is no phosphorus. These spheres are inclosed in others, and the space between (likewise exhausted of air) contains the phosphorus, which is therefore completely shut off from the conducting wires by a screen of glass. On the passage of a current the sides of the spheres become coated with amorphous phosphorus. It may be considered demonstrated that this conversion is effected neither by the light nor by the heat that accompany the current, but exclusively by the electricity itself.

THE DIFFERENCES BETWEEN VOLTAIC AND FRICTIONAL ELECTRICITIES.

In reference to the difference between electricity developed by friction and that developed in the galvanic battery, it has long been remarked that the former, or electricity of high tension, as it is called, excels the other in the development of light by the electric spark, and has a stronger physiological effect upon the nerves and muscles, while its chemical, thermic, and electro-magnetic effects are much weaker. A further difference between these two sources of electricity consists in this, that the galvanic current follows the law of Ohm, varying its intensity with the resistance between its poles, while the current from the electric machine, as was shown by Gauss, remains constant, no matter how great the

resistance of the bodies penetrated by it. The study of the failure of Ohm's formula in this case has been the subject of an investigation by Rossetti, who, among many other conclusions, establishes the following principles: In one and the same series of experiments, conducted under identical circumstances with reference to atmospheric humidity, the intensity of the current excited by the electric machine is nearly, but not exactly, proportional to the velocity of the revolving disk. The relation between the velocity of the disk and the intensity of the current is not independent of the moisture in the air, but varies sensibly therewith, the number of turns the disk must make in a second, in order that a current of constant intensity may be developed, is greater on moist than on dry days. The work required to make the electric machine active is exactly proportional to the intensity of the current, assuming that the humidity remains the same. The ratio between the work and the intensity of the current diminishes with increasing moisture, so that in order, on a moist day, to obtain a current of given intensity, there may indeed be required a greater velocity of rotation; but equally is it true that a less amount of work would be expended, so that the electric machine is more economical on moist days than on dry.—19 *C*, VIII., 140.

NEW MODIFICATION OF THE LECLANCHÉ BATTERY.

M. Kern, of St. Petersburg, after detailing several grave objectionable qualities of the Leclanché cell, at present very popular for telegraphic and other uses, recommends the following modification, which he claims will act very constantly. Two parts of well-washed coke and one of manganese dioxide, in the state of powder, are well mixed together with a small quantity of water acidulated with some drops of nitric acid, and the mixture is then pressed into a cylindrical mould of suitable size. The resulting coke-manganese cylinders are dried in a warm place, but not over a fire, as a strong heat will decompose the peroxide. The dried cylinders are placed in glass jars containing concentrated solution of ammonium chloride, and surrounded with zinc plates curved in the usual manner. By this arrangement the use of porous cells is avoided, and a battery of such elements acts more constantly, besides which the construction is materially cheap-

ened. For the glass jar, the author furthermore substitutes a wooden box of the same size, coated with a mixture of wax, two parts; resin, ten parts; red-lead, two parts; and gypsum, one-sixth part.—1 *A*, XXXI., 203.

SIMPLE METHOD OF MAKING CARBON CELLS.

Mr. Symons gives the following method, as practiced by himself, for constructing plates or cells of carbon of any required shape and size, such as are used in galvanic batteries. With a sirup of equal quantities of lump sugar and water, mix wood charcoal, in powder, with about equal parts of the light powder called vegetable black. The mixture should hang well to the moulds dipped into it, and yet be sufficiently free to form itself into a smooth surface. Moulds of the cells required are made of stiff paper, and secured by wax or shellac. These moulds are dipped into the carbon sirup, so as to cover the outside only, and then allowed to dry. This dipping and drying ought to be repeated until the cells are sufficiently thick; when well dried they are buried in sand, and baked in an oven hot enough to destroy the paper mould. After being cleared from the sand and burned paper, the cells are soaked for some hours in diluted hydrochloric acid, and again well dried, then soaked in sugar sirup. When dried, they are packed with sand in an iron box, gradually raised to a white heat, and left to cool. If some of the cells be cracked, they need not be rejected, but covered with paper or plaster and dipped into melted paraffin. Rods or plates of carbon can be made by a similar process. The carbon thus made will be found to have a good metallic ring, and a brilliant fracture.—12 *A*, XI., 8.

NEW ABSOLUTE GALVANOMETER.

An absolute galvanometer is described by Professor Guthrie, as constructed for him by the Messrs. Elliott. Its principle consists in the determination of the strength of the current, by the measurement of the mechanical force necessary to bring to within a given distance of one another two electro-magnets which are affected by the current in such a manner that they repel one another. The galvanic current whose force is to be measured coils around two fixed soft iron masses, rendering them magnetic, and then around

two movable soft iron masses suspended by a vertical thread. Many of the laws of electro-dynamics may be readily illustrated by this instrument, and not only may different currents be compared with the greatest accuracy, but the absolute mechanical value of the current may be at once arrived at.—7 *A*, XLVIII., 297.

EARTH CURRENTS IN TELEGRAPH LINES.

Mr. Schwendler, who in 1868 was intrusted with the introduction of a system of testing telegraph lines in India, took that opportunity to do his work so thoroughly as to secure all the data necessary for the quantitative determination of the electro-motive force on the line. Over 10,000 determinations have been made during the past six years, and he deduces from these the conclusion that all the lines in India are affected by natural currents of electricity. These currents are, as it were, a negative or copper current, flowing from the east to the west. The strength of the natural current is very variable, even on the same line. The direction is also variable, but far more constant than the strength. The variations in strength and direction, on parallel lines of telegraph, are very uniform. The prevailing direction of the current is generally also the direction of the maximum current. He considers himself now fully justified in establishing further improvements for the purpose of minutely investigating these currents, and his propositions having been strongly urged upon the attention of the Indian government, have been favorably received by it.—*Proc. Asiatic Soc. Bengal, June*, 1874, 145.

VARIATIONS OF SHIPS' COMPASSES.

Sir William Thomson communicates to the British Association for the Advancement of Science an investigation of the perturbations of the compass produced by the rolling of the ship—the so-called "heeling error" which has been studied by Airy and Smith. This heeling error may be defined as the angle between the directions for the ship upright and the ship inclined, the resultant of the horizontal magnetic forces of the earth and the ship at the position of the compass—a definition that would be rigorous for a compass supported on a point in the ordinary manner, if this bear-

ing-point were carried by the ship uniformly in a straight line, and is sufficiently approximate when the compass is placed in the ship's axis of rolling. The perturbation produced in the compass by this rolling will be solely that due to the variation of the horizontal component of the ship's magnetic force. Such a position of the compass would have one great advantage, viz., that the application of proper magnetic correctors adjusted by trial, to do away with the rolling error, would also perfectly correct the heeling error.—7 *A*, XLVIII., 364.

THE FORMATION OF MAGNETS BY ELECTROLYSIS.

In a recent notice of the labors of Jacobi, Beetz considers the question of the formation of magnets by electrolysis. The latter states that on causing iron to be deposited by galvanic action in the interior of a coil, he subsequently found the iron to be magnetic. To secure this result his cathode was a plain metallic plate, opposed to a similar iron plate which acted as a node. An attempt by Jacobi to produce similar action seems to have failed, and the reason for its failure is explained by Beetz as resulting principally from the fact that the electrodes employed by Jacobi were of such a nature, and so arranged, that it was impossible to induce any magnetism in the iron deposited between them; in fact, the molecules of the latter were deposited in a magnetic shade so intense that less than 0.01 of the electro-motive force affected it.—*Poggendorff Annalen*, CLII., 486.

MEASUREMENTS OF TERRESTRIAL MAGNETISM.

Attention is called by Braun to the practicability of applying the inclinatorium to the determination of the intensity of terrestrial magnetism. This was first suggested and applied by Lamont and Lloyd, but seems to have been generally neglected. Braun, however, shows that both theory and practice agree in proving that this method allows of the same degree of accuracy as that attainable by the best magnetometers. In detail he finds that Lloyd's method gives the total intensity more accurately than the horizontal intensity, but by the magnetometer method the reverse is the case. The accuracy of the results obtained by Braun is attributed, in part, to the great perfection of the incli-

nation needles that are now made in England, and he recommends earnestly the inclinatorium as a portable magnetic instrument, upon the score of accuracy, convenience, and cheapness; since with it one may make a complete series of magnetic observations, without also carrying declinometer, magnetometer, reflecting circle, theodolite, or clock. A simple addition to the instrument even allows him to make absolute as well as relative determinations.—*Poggendorff Annalen*, CLII., 619.

NEW METHOD OF INVESTIGATING TERRESTRIAL MAGNETISM.

In an inaugural dissertation of Dr. Haanel, of Albion, Michigan, recently printed at Breslau, Germany, the advantages of the galvano-metric method for the determination of the earth's magnetism and its oscillations are elucidated; he concludes that the method is well adapted to such determinations, and that it will recommend itself by the following advantages: The instrumental constants need be determined only once for all subsequent observations; the oscillations of the declination may be eliminated by properly arranging the observations; Gauss's method of counting the vibrations is dispensed with; the magnetic power of the coil can be increased or diminished at pleasure; and the oscillations of the coil are under perfect control of the observer.—*Haanel's Inaugural Dissertation, Breslau*, 1873, 128.

THE EFFECT OF MAGNETISM ON THE ELECTRIC DISCHARGE.

The last work published by A. De la Rive relates to this subject, in the early development of which he took so active a part, namely, the effect of magnetism on the electric discharge when the latter takes place through a rarefied gas. In an earlier memoir on this subject he studied the case of the magnet acting upon a discharge, the latter being perpendicular to the magnet. He showed that in this case the magnetism produced not only a deviation of the luminous jet, but its condensation, its more intense brilliancy, and a notable diminution of the elastic force of the gas in the portion of the discharge which is more directly submitted to the magnetic action. This augmentation of intensity varies with the nature of the gas. It is least with hydrogen and greatest with air; that is to say, the effect is more marked

in proportion as the gas is a less good conductor of electricity, and the effect is more considerable on that portion of the discharge near the electrode than upon the rest of the column. The electric conductivity of the gas also diminishes, owing to the action of the magnet, and by a quantity that varies very notably with the nature of the gas, being so much more considerable as the gas is a better conductor of electricity. As the result of his later investigations, De la Rive finds that when the magnet is presented to the gas influenced by the electric discharge in such a way that the axis of the magnet is not perpendicular, but parallel to the axis of the discharge, and is, in fact, a continuation of the latter, then all the preceding phenomena are reversed. Further experiments showed that a special and peculiarly intense resistance, having its seat at the issue from the negative electrode, is that which is overcome by the intervention of the magnet. The dimensions of the negative electrode notably influence the dimensions of the aureola.—7 *A*, XLVII., 464.

FORMATION OF MAGNETISM BY ELECTRIC CURRENTS.

Some researches made by Beetz into the possibility of communicating permanent magnetism to the iron deposited by galvanic currents have an interesting bearing, not only upon chemical, but also upon geological theories; he states as the result of investigations into the influence of the chemical nature of the solution employed as an electrolyte, that the iron deposited from solutions containing sal ammoniac is in a peculiar manner susceptible to the reception of permanent magnetism. If the deposition takes place under the influence of a strong magnetism, avoiding injurious circumstances, there are formed from the sal-ammoniac solution strong magnets of uniform structure, while from solutions having no sal ammoniac magnets are formed whose structure is irregular, and whose magnetic power is quite feeble.—*Poggendorff Annalen*, CLII., 494.

THE INFLUENCE OF A MAGNET UPON THE GALVANIC ARCH.

Messrs. Delarie and Sarasin have published the result of some experiments concerning the effects of magnetism on the electric discharge through rarefied gas when the discharge occurs in the prolongation of the axis of the magnet; vari-

ous gases, sealed up in Geissler tubes, have been experimented upon, the discharge from a Ruhmkorff coil being allowed to traverse the gas. Changes occur in the appearance of the luminous discharge where the magnet is excited; these changes are accompanied by a change in the resistance offered to the current by the gas. Thus a tube containing hydrogen permitted the passage of a current marking twenty-five degrees on the galvanometer when the magnet was not excited, but when excited the galvanometer reading was forty degrees. It seems to be a law that the augmentation in the intensity of the current is greater with a gas which is a good conductor than with one which is a bad conductor.—12 *A*, XI., 19.

NEW SOURCE OF MAGNETISM.

M. Donati Tommasi is authority for the statement that if a current of steam at a pressure of from five to six atmospheres is passed through a copper tube of two to three millimeters in diameter, which is spirally coiled about an iron cylinder, the latter is magnetized so effectually that an iron needle, placed at the distance of some centimeters from the steam magnet, is strongly attracted, and remains magnetic so long as the steam is allowed to pass through the copper spiral.—6 *B*, XV., 1875.

MAGNETIC PERMEABILITY OF IRON, NICKEL, ETC.

Mr. Rowland, of Troy, New York, in a paper on the magnetic permeability of nickel and cobalt, states that the views of the English and German philosophers as to the nature of force have given rise to different ways of looking upon magnetic induction. Thus, the Germans would say that this action was due in part to two causes—the attraction of the coil and the magnetism induced in the iron by the coil; the English, following Faraday, on the other hand, would consider the substance in the helix as merely conducting the lines of force, so that no action would be exerted directly on the compass needle by the coil; but the latter would only affect it in virtue of the lines of force passing along its interior, and so there could be no attraction in a perfectly vacant space. According to the first theory, the magnetization of the iron is represented by the excess of the action of the

electric magnet over that of the coil; while by the second theory, when the coil is very close around the iron, the whole action is due to the magnetism of the iron. The natural unit of magnetism to be used in the first theory is that quantity which will repel an equal quantity at a unit's distance with a unit of force. On the second theory, it is the number of lines of force which pass through a unit of surface when that surface is placed in a unit field perpendicular to the lines of force. As the result of his novel and very important researches on the effect of heat on magnetism, Rowland states that if it were possible for the magnetism of substance to attain a maximum value, the co-efficient of magnetism by induction would become, first, zero, and then negative, and the substance would then become diamagnetic for very high magnetizing forces. This principle, announced independently by Maxwell and Rowland, lacks as yet the confirmation of observation, although not contrary to our experience. Our principal hope of confirming it by observation consists in heating some body, and then subjecting it to a very high magnetizing force, for Rowland has shown in the case of iron and nickel the maximum of magnetization of nickel and of iron decreases as the temperature rises, at least between the limits of zero and 220° Centigrade. He finds from observation that if nickel is heated from 15° to 220° Centigrade, the magnetization will increase if the magnetizing force is small, but will decrease if it is large. In general, as the magnetizing force is increased, the resistance of iron, nickel, and cobalt to magnetization decreases, until a minimum is reached when the metals have attained a magnetization equal to from 24 to 30 per cent. of their maximum of magnetization, and after that resistance increased indefinitely.—7 *A*, XLVIII., 32.

IMPROVEMENTS IN THE GRAMME MAGNETO-ELECTRIC MACHINE.

The magneto-electric machine invented by Gramme, which has within the past two years become quite famous, has received an important improvement in that ordinary magnets have been replaced by the plate magnets invented by Jamin, which give it a great advantage, not only because of the greater force for the same weight, but because of the extreme facility of their construction. These plate magnets can be built up and taken apart in a few minutes, an ex-

tremely valuable feature when one is obliged to experiment in order to determine the strength of the current necessary for accomplishing a certain work, and one equally valuable to the physicist who may desire to elucidate obscure points in the theory of the machine. The Gramme machine has been still further improved by combining with its peculiar features the construction due to Wild and Ladd, by which an immense magnetic power is developed from a very slight initial movement of magnetism; by this means an instrument has been produced by which the same electric tension is attained with a velocity one half as great as that originally necessary. In the course of the numerous improvements that Mr. Gramme has made in his original machine, his latest construction seems to leave nothing to be desired. The number of electro-magnets and of coils is now reduced, from six and twelve respectively, to two and four. The ring is virtually doubled, giving far more facility in the application of the same machine to very different objects, such as galvanoplasty, lighting, heating, etc.; in the machines, as originally constructed with a simple ring, each one was only convenient for use for the immediate purpose for which it was designed and proportioned.—13 *B*, III., 139.

THE FRICTION AND THERMAL CONDUCTIVITY OF GASES.

In a memoir by Messrs. Kundt & Warburg on the friction and thermal conductivity of gases for heat, the authors endeavor to investigate the accuracy, at high temperatures and low densities, of the laws deduced by Maxwell, Meyer, Loschmidt, Stefan, and Boltzmann, which for ordinary temperatures and densities hold good in gases; they find, first, that the co-efficient of sliding friction between moving gas and a fixed plane has a determinate value dependent on the nature of the gas, so long as this is present in layers thicker than fourteen times "the mean length of path of the molecules" as defined by the kinetic theory of gases; the co-efficient is also inversely proportional to the pressure. Second, the absolute value of the co-efficient of sliding friction is found to be $0.7 \times l$, on the assumption that the molecule of gas is reflected from the moving surface used in the apparatus with velocities of translation equal to those of the surface itself. For air at 760 millimeters, $l = 0.000083$ millimeter,

therefore the co-efficient of friction should be 0.000058 × pressure; but actual observations give a result very nearly twice as great. Hence it is concluded that in the striking of the molecules against the walls, their velocities are not completely equalized. The absolute co-efficient of friction for the air is given by these authors at 0.000189, being exactly midway between the four previous determinations made by Graham, Maxwell, Meyer, and Puling. The co-efficients of friction for hydrogen and for carbonic-acid gas were determined by them to be respectively 0.488 and 0.806 (that of the air being 1), agreeing closely with the values deduced from the observations of Graham. The co-efficient of friction for pure steam at a temperature of 15° Centigrade resulted about one half of that of air. The investigation into the dependence of the co-efficient of friction on the density or barometric pressure of the gas shows that the diminution of friction with pressure is greater the rarer the layer of gas. Further experiments bearing upon the kinetic theory of gases were made by Messrs. Kundt & Warburg in that they attempted to determine the co-efficient of conductivity for heat. Their approximate result for the atmosphere is one eleventh less than that deduced a few years ago by Stefan; and from these same observations there resulted also the value of the radiating power of glass, which agreed nearly with that of Lehnebach. The variation of the radiating power with the temperature does not seem to them to have been reliably determined in the classical work of Dulong and Petit.—*Monatsbericht der K. Akademie von Preussen, Berlin*, 1875, 160.

THE CONNECTION BETWEEN FLUORESCENCE AND ABSORPTION.

Dr. Sorby, President of the Royal Microscopic Society, states that he has been surprised to find that some of those who have paid considerable attention to such subjects have so far misunderstood the question as to suppose that the light of fluorescence consists of rays which are, as it were, reflected by this solution, and do not penetrate through it, so that the spectrum of the fluorescence would show a bright band in the same place as some dark bands seen in the spectrum of the transmitted light. This is certainly an error, and his own observations agree more nearly with Lubarsch,

who shows that of eight different substances the spectrum of the light of fluorescence extends some distance on the red end side of the principal absorption band in the spectrum of transmitted light; so that the spectrum of fluorescent substances can never contain rays which are more refrangible than those which are most readily absorbed by a very dilute solution. This, although a very general rule, yet has some decided exceptions. In some substances, under strong illumination, the light of fluorescence does contain rays of greater refrangibility than those most readily absorbed by a dilute solution, and extends from the red end a little beyond the centre of the main absorption band. A number of little known and interesting fluorescent solutions are quoted by Sorby in illustration of his remarks.—*Monthly Micr. Journal*, p. 161.

THE ISOCHRONISM OF THE BALANCE SPRING.

William D. Glasgow, in a short article in the *Horological Journal*, on balance springs, states that the isochronism of the balance spring of a watch is a subject bristling with controversy. There are some who say that every spring must be isochronized; others that every length of spring has its isochronous point of suspension; others that mere length has absolutely nothing to do with isochronism. Mr. Glasgow holds that length has every thing to do with it, as shown by his own experiments. Too short a spring, whatever may be its form, will make the short arcs of the balance's vibrations to be performed in a less time than the long arcs. Thus a spring with ten turns may be too short, and will lose in the short arcs and gain in the long arcs. A spring of two turns will be too long, and will describe its longer arcs in too short a period. The best length for a flat spring is, he finds, fourteen turns; but a flat spring, although the most common, is also the worst form, as it does not expand and contract properly. It will assist the action in this spring if it is always a little small, as this gives more freedom to the portion of the coil next to the stud. The Breguet spring, although differing very little in form from the flat spring, is essentially different in action and principle, having perfect freedom to expand in a circle all around. From twenty to twenty-five turns is, he finds, the

best length for this spring. According to his experience, the length of the spring, and the length alone, is sufficient to secure perfect isochronism.—*Horolog. Journal, June*, 1875.

THE VARIATIONS OF TEMPERATURE ACCOMPANYING THE DIFFUSION OF GASES.

Professor Dufour, of Lausanne, Switzerland, as the results of an investigation into the variations of temperature which accompany the diffusion of gases traversing partitions of porous earthenware, states his conclusions as follows: When currents of dry air, of hydrogen or of illuminating gas, circulate along the walls of a porous vase, or of a vase which incloses fragments of porous material, they produce a lowering of temperature. The depression diminishes little by little, and finally ceases altogether. When the currents of the same gas, charged with moisture, circulate under the same conditions, there is produced a heating, which also diminishes gradually, and finally ceases. The warming and the heating are more or less considerable, according to the initial condition of the porous vase. The greatest variations are produced when the dry current succeeds to a saturated current, or inversely. These variations of temperature are probably due to the absorption of aqueous vapor by the porous substance, or to the disengagement of this vapor. If the experiments are conducted under a constant barometric pressure, then, when the air on the one side, and the hydrogen or illuminating gas on the other side, are in contact with the two faces of the porous partition, the diffusion which takes place produces a change of temperature, but a change having a different sign on the opposite sides of the diffusing partition. There is a lowering of temperature on the side where the denser gas is found, or, in other words, on the side where the current arrives most abundantly. There is, on the other hand, a rise of temperature on the opposite side. These variations of temperature have been observed when the gases taking part in the diffusion are dry, as well as when they are charged with aqueous vapor. When the gases are employed without drying, and without saturation, the diffusion also evidently occasions the variations of temperature just indicated; but it is probable that this variation is influenced by the pres-

ence of the vapor of water. The extent of the variation of temperature which accompanies diffusion is different in different cases, according to the special arrangements of the experiments. It is always greatest when the diffusion is most abundant and most active. We can conveniently explain the facts established by supposing that in the diffusion the gaseous current produces a heating on the side where it comes into the porous partition, and a cooling on the side where it emerges. These currents having an unequal importance, depending on their density, we can comprehend that there is, as a result, a warming on one of the faces, and a cooling on the other face of the partition. When the experiments are made under different barometric pressures, we find that, when the endosmose of a lighter gas is accompanied by an increase of pressure in the porous vase, the temperature varies only very little, and generally augments during the endosmose, while the manometer falls after having attained its maximum, and the pressures tend to equalize themselves, the temperature diminishes more or less rapidly, and by a relatively considerable quantity. When the exosmose of a lighter gas gives rise to a diminution of pressure in the porous vase, the temperature varies only a very little, and more generally diminishes during the exosmose. When the manometer rises after having attained its maximum, and the pressures tend to equalize themselves, the temperature augments more or less rapidly, and by a quantity relatively quite considerable. This change of temperature, when the diffusion is accompanied with a change of pressure, is conveniently explained by admitting that the thermic variation due to the diffusion is conformable to the laws above indicated, and is due (but with a certain retardation) to the variation caused by the compression or the rarification of the gas which surrounds the thermometer. —*Bibl. Univ.*, XLIX., 103.

ATTRACTION, REPULSION, AND RADIATION.

Professor Crookes, whose first interesting paper on radiation was read in 1873, has recently made a second communication on the subject, in which are described certain improvements introduced by him, and new forms of apparatus, which enable the phenomena of repulsion by radiation to be

observed and illustrated. A bulb, three inches in diameter, is blown at the end of a glass tube eighteen inches long. In this a fine glass stem, with a sphere or disk of pith at each end, is suspended by means of a fibre of silk. The bulb is then perfectly exhausted and hermetically sealed. Instead of pith, disks may be made of iron, metal, cork, or other substances. The apparatus, when constructed with proper precautions, is so sensitive to heat that a touch of the finger on a part of the globe near one of the disks of pith will drive the index around over a quarter of a revolution, while it follows a piece of ice, as the needle follows the magnet. With a large bulb very well exhausted, a somewhat striking effect is produced. When a lighted candle is placed about two inches from the globe, the glass stem with its pith disks oscillates to and fro through gradually increasing arcs, until several complete revolutions are made, when the torsion of the suspended fibre offers a resistance to the revolutions, and the bar commences to turn in an opposite direction. This movement is kept up with great energy and regularity, like the movements of the balance wheel of a watch, as long as the candle burns. A modification of this apparatus, in which a glass thread is substituted for the silk fibre, allows quantitative as well as qualitative observations. The sensitiveness of the apparatus to heat rays appears to be greater than that of the ordinary thermo-electric multiplier. Thus the obscure heat rays from copper, at a temperature of 100°, after passing through glass, produce a deflection on the scale of 3¼ divisions, while under the same circumstances no current at all is detected in the thermo-pile.—*Nature*, XI., 494.

ROOD'S APPLICATION OF ZÖLLNER'S HORIZONTAL PENDULUM.

The paper of Professor O. N. Rood, on the application of the horizontal pendulum to the measurement of minute changes and the diminution of solid bodies, although read in 1874, has only recently been published; and from it we learn the details of the instrument proposed by him as an improvement on Zöllner's horizontal pendulum. This proposed improvement consists essentially in an inflexible rod placed horizontally, and supported in that position in mid-air by vertical wires or springs, stretched in such a manner that the influence of gravity on the rod is no longer sensible,

while its motion is entirely under the control of the observer. Professor Zöllner's apparatus was designed expressly to measure attractive forces and slight changes of level. Professor Rood proposes to apply his own similar apparatus to the study of minute changes in the dimensions of solid bodies, for which purpose he gives it such dimensions as to impart to it an unprecedented delicacy. The main difficulty in the use of this apparatus is the fact that it is exceedingly sensitive to the most distant and unseen sources of disturbance. Thus Professor Rood remarks that children, playing at a distance of 360 feet, caused temporary deflections of one or two scale divisions; and similar deviations were caused by the lower notes of an organ in a neighboring church, the middle and higher notes producing no sensible results. These effects upon the apparatus can be eliminated, however, by making a sufficient number of observations, the evils caused by them being only temporary. As usual in all investigations, the effects of temperature are the most insidious.

As illustrating the fineness of the measurements that can be made with the horizontal pendulum, Professor Rood gives some figures showing that the one eighteen-millionth part of an inch becomes a sensible quantity; whereas hitherto, with the best optical and mechanical means, it has been hardly possible to measure the two one-hundred-thousandth part of an inch.—*Am. Jour. Sci.*, 1875, IX., 441.

THE ELASTICITY OF BARS OF ICELAND SPAR.

Dr. G. Baumgarten mentions that a lecture of Professor Neumann on the theory of elasticity, in which he called attention to the interest that would attach to the determination of the co-efficients of elasticity in crystalline bodies, led him to undertake this labor, and that, so far as he knows, his own are, as yet, the first direct observations on the elastic properties of crystals. Voigt, however, has since then investigated the elasticity of the crystals of rock salt. Iceland spar was chosen by Dr. Baumgarten, among other reasons because, in reference to its physical and optical properties, it is better known than almost any other mineral. His determinations of its elasticity were made by measuring the bending of bars of spar, when pressed in various directions, and which had been cut in different directions from the crys-

tal. The bars operated upon by him were two inches long, and had a square section of about the seventieth part of a square inch. He finds that the amount of deflection in the centre of a bent bar is a function of many quantities, but his observations allow him to state, first, that the deflection of a bar whose section is a perfect square is the same, no matter against which side the bending force is applied. Second, it varies with the dimensions of the bar as regards its thickness, breadth, and length, precisely as though the body were homogeneous; and the same laws apply to it within the limits of accuracy of his observations as apply to ordinary iron bars, the deflections being proportional to the cube, to the thickness, and to the length. Third, the deflection is dependent in a peculiar manner on the direction of the axis of the bar, in relation to the optical axis of the crystal from which it is cut. There exists, however, in this respect no symmetry with reference to the optical axis of the crystal. Bars cut parallel to the longest diagonal of the crystal give a minimum of deflection; those cut parallel to the shortest diagonal giving a maximum deflection.—*Inaugural Diss., Berlin*, 1875.

A NEW MANOMETER.

M. Fol has submitted to the Physical Society of Geneva a description of a manometer specially designed for deep-sea soundings. This instrument consists essentially of two spherical reservoirs, superposed, and connected by a capillary tube. The upper reservoir should be closed and filled entirely with a compressible liquid—for example, alcohol. The other sphere has an opening in its upper part, and is filled with mercury, which also fills the capillary tube. The quantity of mercury which shall have passed from the second reservoir into the first, when the apparatus has been submitted to a given pressure, will give the measure of this pressure, and consequently of the height of the column of water or the depth in the sea.—*Mem. de Soc. d. Phys. de Genève*, 1874, 483.

THE PHYSICAL PROPERTIES OF MATTER IN THE LIQUID AND GASEOUS STATES.

Professor Andrews, in a preliminary notice of his researches on the physical properties of matter in the liquid and gas-

eous states, says that these investigations have occupied him continuously since 1869. In these he has experimented with gases under a pressure of 500 atmospheres. Of course, great difficulties have been experienced by him in measuring such pressures with accuracy; but the previous difficulties that he has experienced have been, or shortly will be, entirely overcome. His recent experiments fully confirm the conclusions published by him six years ago with reference to carbonic-acid gas, viz., that its contraction under great pressure is greater than it would be if the law of Boyle holds strictly good. Under a pressure of 223 atmospheres, this gas is reduced to $\frac{1}{417}$ of its volume under one atmosphere, being slightly less than one half the volume it ought to occupy if it were a perfect gas, and contracted in accordance with Boyle's law. He infers, by analogy, that the critical points of the greater number of gases not hitherto liquefied are probably far below the lowest temperatures yet attained; and these substances are not likely to be seen, either as liquids or solids, until we can obtain much lower temperatures than those produced by liquid nitrous oxide. Again, the law of Gay-Lussac, like that of Boyle, is true only within certain limits and conditions of gaseous matter; in fact the co-efficient of expansion changes rapidly with the pressure, and if the pressure remains constant the co-efficient changes with the temperature. In reference to the law of Dalton, which is that the particles of one gas possess no repulsive nor contractive power with regard to the particles of another, Dr. Andrews's experiments show conclusively that this is not true; and that the so-called critical point is, for instance, lowered by the admixture of carbonic-acid gas with a non-condensible gas. The law also entirely fails when one of the gases is at a temperature not greatly above its critical point; it only holds good when these gases are at feeble pressures, and at temperatures greatly above their critical points.

ON THE INFLUENCE UPON THE MOVEMENT OF A PENDULUM OF A FLUID CONTAINED IN ITS SPHERICAL BOB.

The illustrious Bessel, in prosecuting his investigations into the force with which the earth attracts various bodies, employed a pendulum having a hollow cylinder of brass as

its bulb, in which he placed the various bodies to be experimented upon. His observations gave him the result that the attraction of the earth was the same for all the bodies upon which he experimented; and his determination of the length of the simple seconds pendulum at Königsberg is one of the most correct we possess. He, however, found that when his cylinder was filled with water, the length of the seconds pendulum as computed for that substance was too great. The origin of this deviation Bessel attributed to the fact that the inclosed fluid was by the swinging of the pendulum set into vibrations of its own, whereby its moments of inertia in reference to the axis of vibration of the pendulum was different from what it would have been in the case of a uniform solid body. He accordingly found that the experiments made with long pendulums filled with water showed no such anomaly as in the case of shorter pendulums. Professor O. E. Meyer, well known for his investigations into the friction of gases and fluids, having suggested a somewhat different explanation, his student, Lubeck, has made this matter the subject of an inaugural dissertation, in which he considers the movement of the fluid contained within a pendulum, whose bulb is, for simplicity's sake, a hollow sphere instead of a hollow cylinder, Lubeck shows that the fluid contained in the hollow sphere is not set in motion by its rectilinear movement, but only by its oscillations about the diameter at right angles to the plane of the pendulum's vibration. This oscillation takes place with velocities which are constant for each spherical surface concentric with the hollow sphere, and any initial oscillatory motion is, in a certain time, destroyed by the inner friction, provided that it is originally of the same order as the velocity of the pendulum itself. After this time had elapsed, the motion of the pendulum is quite periodical. The extent of the arc through which the pendulum swings diminishes in a geometrical ratio when the time increases in an arithmetical ratio. The duration of the vibration of the pendulum is greater than if the same pendulum contained within itself a perfect fluid, instead of one having internal friction. The duration of the vibrations is smaller than if the fluid should be replaced by a perfectly solid body. When the length of the pendulum becomes very great the inner friction of the

fluid has no perceptible influence on the time of vibration.—*Lubeck's Inaugural Dissertation, Berlin,* 1873.

THE CAUSE OF WOLF IN THE VIOLINCELLO.

Mr. Kingsley, in a communication to the Cambridge Philosophical Society, states that the *wolf,* a name given to a well-known defect in the violin, occurs somewhere about low E or E flat, and has been attributed to the finger-board having the same pitch, so that it becomes, as it were, a portion of the string stopped down on it, and vibrates with it. Another explanation is given by Savart, viz., that the violincello is constructed of such dimensions that the mass of air included within the instrument resonates to a note making 85.33 vibrations in a second, a number which formerly represented the lowest F on the C string; but which now, owing to the rise of pitch since the beginning of the eighteenth century, nearly represents the note E immediately below it.—*Nature,* XII., 40.

THE PYROPHONE.

In 1873 Mr. Kastner brought forward his new invention, the pyrophone, which consists essentially of a flame of hydrogen gas, burning within a tube in such a way as to produce the well-known singing sounds on a large scale. If in the tube of glass or any other material, we introduce two or more isolated flames of proper size, and if we place them at a distance from each other one third of the length of the tube, these flames will vibrate in unison. This phenomenon is produced as long as the flames remain separated, but ceases as soon as the flames are brought into contact. It is upon this principle that his pyrophone is based; and the principal objection to the original instrument, which consisted in the necessity of employing hydrogen gas, he has recently overcome, and states that he is now able to employ ordinary illuminating gas; but to do this he is obliged to eliminate the carbon, whereas at first it was impossible to make the tube vibrate with illuminating gas, although the flames were placed in the proper position. According to him, sonorous flames of illuminating gas are in fact enveloped by a photosphere which does not exist when the flame is simply luminous. This photosphere contains a detonating mixture of

hydrogen and oxygen, which determines the vibration of the air in the tube. In order that the sound be produced in all its intensity, it is necessary and sufficient that the number of detonations produced by the molecules of oxygen and hydrogen in a given time shall be in accord with the number of vibrations corresponding to the sound produced by the tube. He finds it sufficient then to increase the number of his flames, substituting four, five, six, or more jets of illuminating gas for his two jets of hydrogen, and diminishing the height of these flames correspondingly, until the sum total of the surfaces of the photospheres suffices to produce the vibrations of the air in the tube.—*Bull. Hebd.*, 1875, 266.

RELATIVE EFFICIENCY OF VARIOUS FOG-SIGNALS.

The principal instruments employed on the American coast as fog-signals are the Daboll reed trumpet, the locomotive whistle, and the siren. In a report on the relative efficiency of these instruments, General Duane states in reference to all of them that, while they are frequently heard at distances of twenty miles, yet as frequently they can not be heard a distance of two miles, and this with no perceptible difference in the state of the atmosphere. It is therefore very difficult to determine the relative powers of fog-signals, unless they are placed side by side, under exceptionally favorable atmospheric circumstances. The sound from the whistle is equally distributed in all horizontal directions, and is most powerful in a horizontal plane passing through the whistle. The sound from the siren is most distinct in the axis of the trumpet with which it is provided. The sound given by the Daboll reed trumpet is usually strongest in a plane perpendicular to its axis. In the average of a great number of experiments, General Duane concludes that the powers of the first-class siren, the 12-inch whistle, and the first-class Daboll trumpet may be expressed by the numbers 9, 7, and 4. The extreme limit of the *audibility* of the sound of the trumpet is twelve miles; that of the 12-inch whistle about twenty miles. That of the siren has not been ascertained. The relative *expenditure of fuel* by the steam-engines working these instruments at their full capacity is, for the siren, 9; the whistle, 3; and the trumpet, 1. As regards the skill and attention required in the management of these signals, the

siren seems to require the most, while the steam-whistle gives the least trouble. As to the anomalies observed in relation to the penetration and direction of sound from fog-signals, General Duane holds that they are to be attributed mainly to the want of uniformity in the surrounding atmosphere, and that snow, rain, fog, and wind have much less influence than has generally been supposed.—*Rep. Light-house Board*, 1874, *Appendix*.

FOG-SIGNALS.

In the appendix to the recent report of the Light-house Board, Professor Henry gives the first account that has, as yet, appeared of the experiments and observations made by him in reference to fog-signals, and especially in reference to the acoustic phenomena exhibited on a large scale in the atmosphere. Among other matters, he states that Professor Bache adopted a very ingenious plan for an automatic fog-signal, which consisted in taking advantage of a conical opening in the rocky coast, generally designated as a blow-hole. On the apex of this hole he erected a chimney, which was terminated by a tube surmounted by a whistle. By this arrangement a loud sound was produced as often as a wave entered the mouth of the indentation. The penetrating power of the sound was, under favorable circumstances, due to the pressure of a column of water twenty feet high, giving a pressure of about ten pounds to the square inch. The effect of the percussion, however, sometimes added considerably to this. In practice it was found that this arrangement, which continued in operation for several years, did not entirely supersede the necessity of occasionally producing sounds of greater power. It is stated that Professor J. H. Alexander, of Baltimore, in his investigations on the use of the locomotive steam-whistles, experimentally demonstrated that the power of the sound depends upon the pressure of the steam in the boiler, and the pitch of the sound depends upon the distance between the edge of the whistle and the circular orifice through which the steam issues. Among the various steam fog-signals, one consisting of a double whistle, improperly called a steam gong, seems of interest. This consists of two bells of the ordinary steam-whistle upon the same hollow axes, mouth to mouth; the upper bell has a

length of axis of twenty inches; the lower whistle is of the same diameter, but of a length of axis of fourteen inches. The note of the shorter bell is a fifth of that of the longer. This arrangement gives a melodious sound, unlike that of ordinary locomotive whistles, and on that account has extraordinary merit; its character being strongly distinct from that of steamboat whistles. In reference to the audibility of signals in different kinds of weather, it was found that a sound moving against the wind, and inaudible to the ear on the deck of a schooner, was heard by ascending to the masthead. In general, it was stated that when the fishermen in the morning, on the Banks of Newfoundland, hear the sound of the surf to the leeward, or from a point toward which the wind is blowing, they take this as an inevitable indication that in the course of from one to five hours the wind will change to the opposite direction from that in which it is blowing at the time. General Duane states that the fog-signals at Cape Elizabeth, and at Portland Head, which are respectively nine and four miles southeast of Portland, can be heard in the latter city much better during a heavy northeast snow-storm than at any other time, although the sound comes to the city in nearly direct opposition to the course of the wind. The most perplexing difficulty, however, arises from the fact that the signal often seems to be surrounded by a belt in which the sound is entirely inaudible. Thus, in moving directly from the station, the sound is audible for the distance of a mile, is then lost for about the same distance, after which it is again distinctly heard for a long time. This action is common to all sound signals, and has been at times observed at all the stations; even at one where the signal is situated on the bare rock, twenty miles from the mainland, with no surrounding objects to affect the sound.—*Rep. Light-house Board*, 1874, *Appendix.*

ON CELESTIAL PHOTOMETRY.

Professor Thury communicates to the Physical Society of Geneva a very full description of a new photometer adapted to astronomical purposes, and also some general considerations upon photometry. It is not at present necessary, as it was fifty years ago, to insist upon the importance of photometric observations in astronomy. We know that the problems

of the distribution of the stars in space, and the gradual modifications that celestial bodies undergo in their own nature, are intimately connected with the intensity of the light we receive from them or that they send out; but it would be impossible to find a collection of photometric observations sufficient to serve as a basis for safe deductions. Either the accuracy of the observations is too small, or there are not enough of them. The observations that we have are due, for the most part, to experienced observers, and the differences between their methods of research fully explains the diversity of their results. In order to make their observations comparable with each other, and to eliminate causes of error peculiar to each method, it is necessary to institute comparative observations by making use of each of the methods employed hitherto in photometry. The results of such an investigation, which has already been commenced in Germany, will probably be, first, a general accordance of the figures obtained by different methods, sufficient to give confidence in their exactness. Second, the knowledge of the means proper to bring about such an accordance; that is to say, a knowledge of the universal corrections and of the improvements necessary to be introduced into the apparatus, and the methods of employing it. Finally, we shall know which of the photometric methods permits the greatest degree of exactness, and which offer special advantages. In general the photometers hitherto employed may be divided into two categories: First, those where the object affected by the light is the eye itself. Second, the physical and chemical photometers, where some inert body is modified by the light. Of these latter, that of Leslie and the photographic photometers are instruments especially adapted to measure separately the intensity of different kinds of radiations. Visual photometers are divided into two classes. In one we diminish the brightness of the light until it disappears from the sight, or, rather, until it becomes too feeble to enable us to distinguish certain definite details of objects, and we then calculate the quantity of the diminution by knowing the methods employed to produce it. These are the photometers of extinction; such are those of Arago, Xavier, and Maistre. The second class of visual photometers is that of comparison, where the two lights present themselves at

the same time to the eye, and we diminish the brighter one until it becomes of equal intensity to the feebler. The quantity of this diminution measured as a fraction of the primitive intensity expresses the comparative brightness of the two lights. In place of estimating directly the equality of the brightness of the two images, we can oppose them one to the other, giving birth to phenomena such as will render their perfect equality more sensible—for example, by transforming and transmitting the inequality of intensity into the production of color. The photometers of comparison which possess the greatest perfection can perhaps be called photometers by opposition; such are those of Wild, Bunsen, Dove, and one of Arago's photometers. The essential part common to all photometers by comparison and by extinction is that which is designed to diminish the intensity of the light, under the condition that the quantity of this diminution shall be exactly measurable. To this end, recourse has been had to the eight following methods: First, the absorption of the light by an apparently transparent medium of variable thickness. Second, reflection from a polished surface at a variable angle. Third, reflections from one, two, three, or more surfaces respectively, at an invariable angle. Fourth, the reduction of the intensity by a deviation by means of reflection of a portion of the light. Fifth, reduction of the intensity by two polarizing systems or planes of polarization by inclining them to each other at an invariable angle. Sixth, reduction by bifurcation of the ray in a double refracting prism. Seventh, reduction by the increasing separation of the rays of a conical pencil. Eighth, exclusion of a portion of the beam of light which enters the pupil of the eye. This exclusion may be accomplished by means of a diaphragm placed either near the eye or in front of the objective of the telescope, or within the terrestrial telescope at the place occupied by the small diaphragm of the quadruple ocular. Of all the combinations that we have enumerated, Thury has chosen one of the most simple, viz., a photometer having a variable diaphragm and reflecting mirrors. His instrument is adapted to a four-and-a-half-inch refractor of excellent defining power, and has since 1868 been applied especially to the nebulæ and the components of double stars. The photometric system adopted is, there-

fore, that of the visual photometer by extinction. The enfeebling of the light is obtained by reflection from one or more mirrors situated between the objective and the ocular, and by a diaphragm having a variable opening placed in front of the objective. This diaphragm is composed of sixteen thin rectangular plates, sliding simultaneously and uniformly each in the direction of its length, and the direction of the radius that passes through the centre of the objective. The polygon of a variable diameter and symmetrical form is the real aperture of the objective. When the aperture of the telescope is diminished too much, the dimensions of the false disks of the stars increase, and the diffraction rings that surround the false disk become so modified that the conditions of visibility are no longer the same for two stars viewed with very different apparatus. It is necessary, therefore, to correct this source of error by diminishing the brightness of the brightest stars, not by contracting the aperture, but by introducing the use of mirrors. A comparative table is given, showing the relative effects of mirrors and diaphragms. Two classes of scales have been adopted in expressing the orders of brightness of the stars. The photometric scale of Sir John Herschel was based upon the simple fact that the intensity of light diminishes as the square of the distance. The brightness of the stars belonging to the first, second, third, etc., magnitudes on his scale was therefore respectively one quarter, one ninth, one sixteenth, etc. The system more generally followed is such that the brightness of a star of any order is always a certain constant fraction of the brightness of a star of the next succeeding order, so that the arithmetic series of magnitudes corresponds to a geometrical series of intensities. The constant ratio in this system would naturally be so chosen as to change as little as possible the magnitudes that have been somewhat arbitrarily assigned to the stars by many generations of astronomers. The actual photometric series of Sir John Herschel accords remarkably well with the ordinary scales of magnitudes, if we simply multiply his magnitudes by 1.41, and take for the unit of intensity a star equal to that of Alpha Centauri. But the photometric scale of this astronomer offers grave inconveniences, which have hitherto prevented its being adopted. The smallest star visible in the twenty-foot

reflector of Sir William Herschel, and which is at least of the twentieth order of magnitude according to the scale used by this astronomer, belongs in fact to the three hundred and twentieth order of magnitude on the photometric scale. The geometric scale offers none of these inconveniences, although, on the other hand, it leaves something arbitrary in the choice of the constant factor of the progression. In both scales the standard of magnitude must be adopted as the fixed point of departure; this is an arbitrary point, whose selection demands much careful consideration. The choice of this unit of brightness may depend upon the following considerations: First, it may be a star of invariable brightness (if such exist). Second, it might be an artificial light, if we take means at hand for producing a light of constant value. Third, it may be determined by the effect upon either the eye itself, or upon the inert bodies that are employed in the photographic process. As regards the eye, it should be remembered that the image found upon the retina depends upon the more or less perfect adjustment of the eye of the observer, and, second, that the aperture of the pupil is variable within very considerable limits. These two latter sources of uncertainty may be remedied by simple means, when it will be found that it is highly convenient to adopt as a standard the faintest stars visible to the normal eye. This unit having been determined by many observers for many stars, the average of all will be a unit representing the average sensitiveness of the human eye, and independent of fluctuations in the brightness of the stars, and which therefore is sensibly constant.—*Bibliothèque Universelle*, 1874, 209.

FLOW OF AIR THROUGH ORIFICES.

An extensive series of observations has been made upon the flow of air through orifices, and its discharge under great pressures, by Professor Fliegner and Dr. Zeuner, of the Polytechnic School at Zurich. The velocity of discharge can be obtained theoretically from the kinetic theory of the constitution of gases, according to which theory the molecules are, at relatively great distances from each other, moving in straight lines, except when they impinge on each other, or on the walls of the contained vessel, in which cases they rebound as if perfectly elastic. Applying

the formula thus deduced theoretically to the observations made by Zeuner, Weisbach, and Fliegner, it seems to result that, for the atmosphere, the "co-efficient of discharge," as determined by Weisbach, is equal to the "exponent of discharge," as that term is used by Zeuner, and is represented by the number 1.41. In the investigations of this latter physicist, certain resistances have been taken into account, such that, in general, the co-efficient and the exponent of discharge will be different for different fluids. It is in those cases in which the internal resistance or viscosity of the fluid is 0 that the co-efficient and the exponent of discharge become equal.

THE INVISIBILITY OF MINUTE BODIES.

The invisibility of minute bodies subtending a sufficient visual angle to be readily seen if properly defined, is a highly curious and important fact. This depends upon several causes that have been examined by Dr. Pigott, in a paper lately read before the Royal Microscopical Society. Minute bodies are often solely distinguished by the sharpness and decision of their outlines. The question is, can this outline be altered by the conditions of vision, or by any relation between the refractive index of the substance and the aperture of the objective? In examining minute globules of glass, or minute spherical bubbles within a larger mass of glass, we notice a very perfect picture of such objects as are beyond the globules, and the whole surrounded by a black band. The field of view is found to be precisely three fifths of the diameter of the bubble; the breadth of the band being the same when we look at the bubble for all objectives, whatever may be the aperture; but when we look at a solid spherule, we find that the breadth of the band increases from nothing up, until it occupies the whole spherule as we diminish the aperture; the angular aperture at which the black band first appears varies with the refractive index of the glass bead. It results from these observations that the aperture of the objective regulates the appearance or disappearance of the circular black outline of minute refracting spherules, or the black bands of refracting cylinders. It thus appears that the aperture of the microscope objective must be adapted to the refractive index of

the substance under examination, in order that we may be able to distinguish minute spherules, cylinders, or other bodies from each other. In the course of his paper, Mr. Pigott states that no glass yet constructed, whether microscopic or telescopic, has been adequate to present to the eye the real size of the image of the sun reflected from a small spherule. With a telescope, the disk, which ought to be the $\frac{2}{1000}$ of an inch, appears something like the $\frac{1}{10}$ of an inch in diameter, or the spurious disk is five hundred times larger than the reality. He concludes from many careful experiments that microscope object-glasses are more finely constructed than the telescopic, but that great improvements are still necessary in that direction.—*Monthly Microscopic Journal, Feb.*, 1875, 55.

RECENT IMPROVEMENTS IN THE MICROSCOPE.

The President of the Royal Microscopic Society, in his late anniversary address, states that the past year has been marked with decided improvements in the construction of microscope object-glasses. A remarkably fine one-eighth inch has been made by Messrs. Powell & Lealand. The image borne by this lens bears amplification by deep eyepieces exceedingly well. Mr. Wenham has constructed a one-seventh inch on an improved formula, obtained by substituting two plano-convex lenses for the single plano-convex posterior lens originally employed. The new lenses are superior in definition, and far superior in clearness and absence of fog or milkiness, to any other objective known to him. As regards fog, this defect is very conspicuous in the one-sixth inch made by Ross, which is constructed of a single front lens followed by three cemented combinations. There are some reasons for surmising that fog is partly due to the multiplication of cemented contact surfaces; and if this be so, the general principles of analysis would lead to the conclusion that the amount of the defect in question would be in proportion to the square of the number of cemented surfaces. Thus, this one-sixth inch of Ross, which has four cemented surfaces, might be expected to present four times as much fog from that cause as the one-seventh inch recently made by Mr. Wenham, which has only two cemented surfaces.—*Monthly Microscopic Journal*, 1875, 98.

TESTING MICROSCOPE OBJECT-GLASSES.

Dr. Pigott advocates the method of testing the object-glasses of microscopes by examination of the miniatures reflected from small globules, especially the examination of the sun's image as seen reflected in small globules of mercury. In this method, an object-glass of fine quality is screwed into the sub-stage of the microscope in an inverted position. On black velvet there are scattered, from a syringe containing mercury, a number of mercurial globules; then, by means of a prism, a brilliant light is thrown vertically downward upon them. The object-glass to be tested is now screwed to the nose of the microscope. The two objectives are brought to a central position, so that their axes coincide, and the instrument is then adjusted to form miniatures of the globules for examination. The most beautiful effects are seen under sunlight. The miniatures develop appearances of marvelous beauty and variety. The aperture of the miniature-making objective should be at least as wide as the objective to be tested, and the lens of the finest quality obtainable. Among the innumerable illuminated objects that may be used, Dr. Pigott strongly recommends what he calls the fundamental experiment; that is, a disk of intense light as small as possible, viewed from a distance sufficiently great to develop the test diffraction rings. It is well known that the surface of the illuminated globules of mercury becomes more nearly spherical as they diminish in weight. The law of the curvature of these surfaces dependent upon the specific attraction of mercury has been investigated by Professor Bashforth, though not yet published. Under direct illumination, a minute spectrum of the sun may be described. The symmetry, beauty, and fineness of refraction rings exhibited by these miniatures from illuminated globules of mercury are severe tests of the objective, and afford delicate means of adjusting its corrections.—*Monthly Microscopic Journal*, 1875, 147.

ACCIDENTAL OR SUBJECTIVE COLORS.

Mr. Plateau states that observations made by himself upon a number of persons of his own acquaintance have

shown him that it is impossible to adopt the principle that the accidental or subjective color observed when we cease contemplating a bright object has always a tint complementary to that of the object itself. This subjective tint depends upon the eyes of the observer; and the cases where the principle is satisfactory constitute rather the exception than the rule, at least so far as concerns blue and yellow. Therefore, in a recent communication to the Belgium Academy, he says that he must continue to maintain the general theory, with reference to accidental colors, that he published forty years ago, and which he thinks has not been sufficiently considered by recent authors. His theory consists essentially in the following propositions: First, during the contemplation of a colored object, the retina exerts an increasing reaction against the action of the light which falls upon it, and tends to throw itself into an opposite state. Consequently, after the disappearance of the object, it takes spontaneously, or, as it were, by inertia, its opposite state, whence results the sensation of the accidental or subjective color. Then it comes to repose by a sort of oscillation, in virtue of which it passes alternately from the accidental to the complementary tint, and *vice versa*. The physiological condition of the retina after the prolonged action of light is very nearly like the state of a body which, drawn from a position of stable equilibrium, then abandoned to itself, returns to repose by a series of decreasing oscillations. Second, analogous phenomena take place in reference to space; while one portion of the retina is submitted to the action of a colored light, the surrounding portions throw themselves into the opposite state; whence results, all around the colored image, an aureole of the accidental colors, and, finally, beyond this aureole there is a tendency toward a manifestation of a cloudiness of the same tint as that of the primitive image. Such a state of the retina can but be compared to that of a vibrating surface, in which the nodal lines are separated by vibrations in opposite directions. This theory has, he says, been adopted in France, but is quite rejected by the German and English physicists. He has been so occupied by his extensive researches into the phenomena of thin liquid films that he has not until lately found time to defend his theory. In the memoir in question he adduces

numerous observations tending to disprove the theories of Scherffer, and of those who have followed him, as also the theories of Thomas Young and his followers.—*Bull. Ac. Roy., Belgique*, 1875, 100.

REFLECTION OF THIN FILMS.

Govi has made a happy application of that principle in optics by which thin films can at the same time reflect and transmit rays of light according to their angles of incidence. He applies a film of gold to the hypothenuse of a right-angled prism of glass; the film allows direct rays to pass through the prism, while the latter reflects the oblique rays coming through the microscope. By placing this prism obliquely upon the ocular of a microscope, the magnified image is reflected upon a sheet of paper, where it can be drawn by the observer who looks through the gold film.—*Rev. Sci.*, 1874, 167.

SIEMENS'S ELECTRICAL PYROMETER, AND DIFFERENTIAL VOLTAMETER.

We had occasion some years ago to give some account of the very elaborate investigations made by Weinhold in reference to the reliability of the various methods employed for measuring very high temperatures accurately, and to call attention to the fact that his researches fully substantiated the claim of Dr. Siemens that the electrical pyrometer, as constructed by him, was a thoroughly reliable instrument. It is now a pleasure to be able to refer to the very important memoir of Dr. Siemens himself, just published in the *Journal* of the Society of Telegraph Engineers. This memoir, which was in part delivered as a lecture in 1871, has been delayed in its publication, owing to the innumerable interruptions experienced by the author in consequence of his professional duties. The fullness of its details shows how large a series of experiments Dr. Siemens undertook to satisfy himself of the accuracy of his method of measuring temperatures.

His memoir consists, first of all, of a very suggestive chapter on the influence of temperature upon the electrical resistance of metallic conductors, which he expresses as a function not only of the temperature reckoned from the absolute zero,

but, first, of the co-efficient of increase peculiar to the particular metal under consideration; second, of the co-efficient of increase dependent upon the co-efficient of the expansion of the metal; and, third, of a function of a co-efficient expressing the resistance of the material at the absolute zero. He finds his formula correctly applicable to the metals platinum, iron, copper, aluminum, and silver, at temperatures between zero and 350° C. The results of his experiments are given in detail, and afford a valuable basis for still further investigations.

In the second part of his memoir he states that, in 1860, when engaged in examining the electrical condition of the Malta and Alexandria telegraph cable, his attention was directed toward the fact that the increase in the temperature of the cable could be measured by the increasing resistance to the electrical current; and accordingly constructed coils of cable wire, of known electrical resistance, inclosed hermetically in iron tubes, out of which passed thick insulated wires; and placing these coils at various points within the mass of the cable, he was able, by examining the varying electrical resistances, to ascertain that the interior of the large mass of coiled cable was steadily rising in temperature, and by pouring cold water thereon saved it from ultimate destruction. Following up this idea, he shortly afterward constructed thermometer coils, consisting of a spiral or insulated wire, inclosed in a cylindrical silver casing, which he used for measuring ordinary temperatures on land, and which could be used, he suggested, by physiologists and others. The instrument is extremely sensitive, being correct within one tenth of a degree Fahr., or even less; and a modified arrangement of this kind for measuring deep-sea temperatures was presented to the Berlin Academy in 1863. After describing the method adopted by him for determining the temperature of a distant spot, and also a similar apparatus furnished by him to the steamship *Challenger* in her exploring expedition, he gives in detail the method of construction of the pyrometer for measuring high temperatures. He states that Professor Bolzain, of Kasan, is at present employing his resistance thermometer for registering the temperatures below the surface of the earth, and measuring the temperature of the air above; and, furthermore, that Mr. Bell,

the eminent metallurgist, habitually employs his pyrometer for the determination of the temperatures employed in various operations of the blast furnace.

The third part of Mr. Siemens's paper is a highly suggestive and valuable memoir on a simple method of measuring electrical resistances. He states that although a Wheatstone balance furnishes electricians with the means of measuring the resistances of electrical circuits with great accuracy, yet its application is, in many cases, rendered difficult on account of the delicacy of the apparatus and of extraneous disturbing causes. As a portable instrument, and one especially applicable to observations on shipboard and in exploring expeditions, he proposes what he calls a differential voltameter, which consists of two similar narrow closed tubes fixed vertically to a wooden frame, with a divided scale behind them, and whose lower ends, being enlarged somewhat, are fitted with wooden stoppers saturated with paraffin, and penetrated by platinum wires. Diluted sulphuric acid is admitted into these tubes, and kept at a proper height in each by a very simple device, and the evolution of gas that occurs, when a current passes from the electrodes, affords the measure of the strength of the current. By means of a commutator the current from the battery is easily reversed every few seconds, preventing polarization of the electrodes. By introducing the resistance of the voltameter, and the unknown resistance x, first on one, and then on the other side of the arrangement, the observations, by a simple arithmetical process, give the exact value of the unknown resistance. The measurement of the quantity of decomposed gases serves merely to determine the relative intensity of the currents which flow in the respective positions of the commutator. He states that, having measured numerous resistances by this instrument, and compared the results with measurements obtained by a very perfect Wheatstone bridge arrangement, he finds that it may be relied upon within a half per cent. of error of observation. The instrument especially recommends itself for use on board of vessels, as not being in the slightest degree influenced either by the motion of the vessel or by the magnetic influence of moving masses of iron. One of its intrinsical advantages is that it gives the resistance to be measured in units of work done,

independent of such momentary changes in the strength of the current as affect the readings of a magnetic needle. It is also portable and inexpensive.—*Jour. Soc. Teleg. Engineers*, 1875, 296.

THE ACTION OF AN ELECTRO-MAGNET UPON THE SPECTRA OF RAREFIED GASES TRAVERSED BY ELECTRIC DISCHARGES.

M. Cheautard states that he has examined the spectra of rarefied gases illuminated by an electric spark, and subjected to the influence of powerful magnets, and finds that these spectra are characterized as to the position, the number, the separation, and the fineness of their lines by very curious traits peculiar to each gas. As regards the metalloids with which only his experiments have thus far been conducted, he states that the light given out by sulphur and by selenium experienced a notable diminution under the influence of the magnet, so that sometimes the spectrum, which was very apparent at first, disappeared for some moments. On the contrary, chlorine and bromine are characterized by an increase in brilliancy, and by the development of fine brilliant rays especially numerous in the green, whose appearance or disappearance at the moment when we turn on or interrupt the current has a truly magical effect. This phenomenon seems to have some importance in consideration of the obscurity which at present characterizes our knowledge of the relation of magnetism and light.—1 *B*, 1875, 283.

THE FREEZING OF SALT WATER.

Professor Guthrie, in continuation of former researches on the solutions of salt, has endeavored to ascertain the manner in which mixtures of salt act as cryogens, and to study their combination with water at various temperatures and in various proportions. He finds that when two salts, composed of different acids or bases, are mixed, and no precipitation occurs, it is generally considered that partial decomposition takes place, two new salts being formed; but he finds that if the salts $a\ x$ and $b\ y$ be mixed in atomic proportion, and dissolved in the smallest possible amount of water, a mixture is obtained identical with that produced on mixing $a\ y$ with $b\ x$; and the temperature and composition of the resulting cryohydrate are the same in both cases. Thus, a

saturated solution of a mixture of nitrate of potassium and sulphate of sodium solidifies at $-5°$. A mixture of nitrate of sodium and sulphate of potassium also solidifies at this temperature; but the temperatures never fall as low as the point which could be reached by employing whichever of the salts $a\ x$, $a\ y$, $b\ x$, or $b\ y$ forms a cryohydrate with the lowest temperature. Thus, in the above case, the solidifying point of nitrate of sodium is $-17°$.—*Nature*, XI., 440.

ON UNILATERAL ELECTRIC CONDUCTIVITY.

Dr. Arthur Schuster states that in the course of many experiments he has had frequent occasion to remark that electric currents seem to traverse copper wires more easily in one direction than in the other; so that the galvanometer indicates different intensities when we reverse the direction of the current which traverses it. He gives to this phenomenon the name of unilateral conductivity. He first observed it in using the galvanic battery, but was able to make more accurate observations by means of magneto-electric machines. The phenomenon observed with this apparatus led him to the hypothesis that the current induced by one pole of the magnet traverses a circuit more easily than that induced by the opposite pole. In his second memoir Schuster records another phenomenon which is not without analogy with the preceding. He joined the electrodes of a galvanic battery to the apparatus which he had used in his first experiment, and found that, whatever the intensity of the continuous current might be, or the relative positions of the electro-magnet to the battery, it always happened that the initial deviation of the galvanometer needle augmented during the rotation of the magnet. On the other hand, as long as the magnet was immovable, it exerted no influence upon the deviation produced by the permanent currents. Noting then, at first, the initial deviation of the needle while the magnet was stationary, he interrupted the current before turning the magnet, and observed again the deviation produced at the first passage of the current during the rotation. The difference between these two deviations was sensibly proportional to the intensity of the permanent current, but decreased rapidly with the increase in the electric vibrations produced by the magnet. The cause of this singular

influence of the rotation of the magnet upon the intensity of the permanent current is scarcely less obscure than that of the unilateral conductivity; and the explanation of the one phenomenon involves the apparent contradiction of the other.—*Bull. Hebd.*, 1875, 297.

SINGULAR PROPERTY OF ALUMINUM ELECTRODES.

A singular property of aluminum has been noticed by Ducretet. A voltameter, whose electrodes are respectively aluminum and platinum, allows an electric current to pass, or prevents it, according as the electrodes are respectively positive or negative. If the positive current passes from the platinum to the aluminum, no unusual resistance is experienced. If, on the other hand, a positive current passes from the aluminum to the platinum, the current is nearly arrested, and the needle of the galvanometer marks in the first case, for instance, 22°, and in the second case 2° only. The explanation of this seems to be that in the former, or favorable case, the current disengages oxygen at the platinum and hydrogen at the aluminum pole. But in the opposite case the oxygen is produced at the aluminum pole, and forms a layer of alumina (or the oxide of aluminum), to the presence of which the arrest of the current must be attributed. If the poles are placed in hydrochloric acid, the phenomenon no longer takes place, and similarly does it not follow if we employ any alkaline liquid. In opposition to this explanation, however, it must be granted that the microscopic examination of the aluminum electrode does not reveal any apparent change in its appearance, no matter in which way the current flows. Whatever may be the explanation, the fact remains, and is certainly a very striking one. Of course, if both electrodes are formed of aluminum, the current will not flow in either direction. Ducretet proposes to apply this interesting property of aluminum in the construction of a telegraphic apparatus, which he calls a rheotome of constant direction.—13 *B*, III., 218.

ON THE ELECTRIC DISCHARGE.

The electrical sparks of a peculiar nature that have been called "feeble sparks" by Riess, by whom they were first discovered, are distinguishable from the ordinary bright

sparks, not only by their form, their light, and their noise, but also by other peculiarities, such that a further investigation into their nature has been made by him. Among the isolated points considered in connection with these feeble sparks, Riess states that Wiedemann and Ruhlmann have from special investigations concluded that the quantity of electricity necessary for a discharge is much greater when the discharge takes place from the negative than from the positive electrode. But his own experiments seem to him not to justify so positive an expression, as they can be explained by means of the feeble glimmer that precedes an eruptive discharge. We have, moreover, no experiments which would lead us to think that there is a greater quantity of electricity present in a positive than in a negative spark. From experiments made with the Holtz machine, he concludes that the greater length of the negative electrode is not an important condition in producing feeble sparks, but that in these experiments electrodes may be employed of any length whatever. The feeble sparks are, not only in reference to their length, but also to their light and brightness, independent of the composition of the arms of the discharger by means of which they take place.—*Monatsbericht der Berlin Akad.*, 1875, 152.

TELEGRAPHIC GROUND CURRENTS.

Speaking of the importance of observing the underground or so-called earth currents on electric telegraph wires, Sir William Thomson states that an observation which would be of value for scientific study is to observe the indication of the electrometer at each end of the telegraph line at any time—whether during a magnetic storm or not—during the day or night. If the line be worked with a condenser at each end, this observation can be made without in the slightest degree disturbing the practical work through the line by simply putting on an electrometer in direct connection with the line, and connecting the outside of the electrometer with a proper earth connection, when it may be observed, quite irrespectively of the signaling, when signaling is done, as it very frequently is, on submarine lines with a condenser at each end. The scientific observation will be disturbed undoubtedly by the sending of messages; but the

disturbance is only transient, and in every pause at the end of a word there will be a sufficiently near approach to steadiness in the potential at the end of the wire connected with the electrometer to allow a careful observer to estimate with practical accuracy the indication that he would have were there no work of the line going on at the time. A magnetic storm of considerable intensity does not stop the work—does, indeed, scarcely interfere with the work of a submarine line in many instances—when the condenser is used at each end. Thus observations, even when the line is working, may be made during magnetic storms, and again during hours when the line is not working. Any single observation, or any series of observations, that are made on the electric potentials at one end of the insulated line will give valuable results. When an arrangement can be made for simultaneous observations of the potentials of the electrometer at the two ends of the line, the results will be still more valuable. We may substitute, with satisfactory results, for the electrometer, the galvanometer of very large resistance.—*Jour. of the Soc. of Telegraph Engineers*, III., 1874, 10.

THE ELECTRICAL VOTING MACHINE.

Monsieur J. Morin has presented for inspection a model voting machine constructed for a deliberative body of twelve voters, in which he proposes to simplify, in a considerable degree, the tedious process of voting, and to economize the time of an assembly. To attain this end the machine ought to be prompt and certain, and free from errors as to the result of the votes. It is composed of a portable table, having twelve circular openings, below which are written the names of the members, each opening corresponding, by invisible wires, to the place of the representative named upon the table. Beneath are placed two small openings closed by small covers, which disappear at the end of the operation, so as to allow one to see the number of votes that have been cast for and against the project. Each of the deputies has also two balls, black and white, corresponding to the opening which belongs to him in the table. The operation of the process is as follows: The deputy, by touching a button, draws before the opening placed upon the table and under his name

a disk of the same color as the ballot that he wishes to throw, and which closes the opening. By the interior arrangement of the machine, a vote being once made prevents the expression of a second, so that it is impossible to vote twice. When the president is sure that every one has taken part in the vote, he touches a special button placed at the side of the machine, and instantaneously the work of addition begins. In this operation, by an ingenious contrivance, the white balls are separated from the black, and the totals thus formed occupy two appropriate places upon the table. At this moment the little covers remove themselves, and allow one to see the figures resulting from the addition. At the moment when the president sets the process of addition into operation, all voting is suspended, so as not to derange the work. Upon the back of the machine there is a system of needles corresponding to each of the openings, which, as soon as the vote is terminated, prints the result upon a sheet of paper prepared for this. A lateral lever permits the reinstating of every thing in its initial condition, ready for a new operation. All these operations are performed by electricity and instantaneously, and the author says that one minute will suffice to count the votes of an assemblage of seven hundred and fifty persons. The complete machine is now manufactured to order in Paris, the cost being about twenty dollars per voter. — 1 *B.*, 1875, 206.

THE THEORY OF THE ELECTRICAL MACHINE.

Poggendorff states that few problems in physics have as yet defied all theories so completely as those offered by the electric machines. Theories there are in plenty; but none explain all the facts, and none are free from unwarranted assumptions. He himself inclines to the opinion that it will not do to assume that the particles of electricity are spherical, and exert their action equally in all directions; but that it is more likely that they are polarized; that they have a definite range on the electrified surface; and that in consequence of the movement of this surface the particles themselves turn. The development of this idea, which is in opposition to the assumption of two electric fluids, as commonly held in Germany, seems, however, to him to be attended

with insuperable difficulties. He appears to have been led to this suggestion by observing the effects produced by turning the revolving plate of an electric machine of the second class through measured angles of 45°, 90°, 135°, etc., instead of turning it steadily throughout the entire circumference.—*Berlin Akad. Monatsb.*

THE ELECTRIC CONDUCTIVITY OF LIGNEOUS SUBSTANCES.

Count Du Moncel has investigated the question as to whether the conductivity of wood fibre, if electrified, is due to the humidity with which bodies are more or less impregnated. His experiments, being conducted with extremely sensitive apparatus, have led him to the following conclusions: A small frame of oak, regarded by the cabinet-maker as being very dry, furnished, when it was brought to him, a deflection of 55° of the scale of the galvanometer. This same small frame, when it had been dried for two hours in the stove, gave not the least deflection, and being kept in a sunny chamber for several hours did not increase its conductivity. Exposed to the air during a dry July night, it gave in the morning a deflection of 13°. It appears from his experiments that it is to the humidity aspired through its pores that the wood owes its relative conductivity, and that this conductivity is proportionate to the degree of pressure upon the metallic plates by means of which the electric current is communicated to the block of wood.—*Proc. Soc. Teleg. Engineers.*

CIRCULAR MAGNETIC NEEDLES.

A report has been presented by Duchemin on the experiments made on board of the French vessels *Faone* and *Savoie*, upon the properties of magnetic needles made in the form of a circular disk, instead of a pointed or lozenge-shaped one. Two series of experiments were made: first, with reference to the comparative steadiness of the simple and the circular needles; second, with reference to the correction of the circular needle for local influences by the addition of a concentric movable circular magnet. The sensibility of the circular needle, according to him, leaves nothing to be desired, being superior to that of the ordinary compass, although its friction is greater, since its weight is more than twice as great. The

stability of the circular needle, as shown by its oscillations to the right and left, is greater than that of the ordinary needle; and its moment of inertia is, in fact, equal in all positions. No difficulty is experienced in locating the position of the magnetic axis of the circular needle. These needles are magnetized instantaneously by means of a powerful soft-iron electro-magnet. He concludes that the circular compass-needle is an instrument worthy of navigators; and by perfecting its construction we shall come into possession of a simple, sensitive, stable instrument, constituting a veritable improvement on the present arrangement. It is even stated that the extreme sensibility that can be given to this instrument may render it advantageous in magnetic observations. A portion of the errors of the instrument, due to local attractions, may be corrected by means of a circular magnet; but this is not to be recommended, as new complications are thereby introduced.—*Bull. Hebd. Assoc. Scientifique.*

CORRECTIONS OF THE COMPASS ON IRON SHIPS.

From an elaborate memoir, by Garbich, on the theory and practice of the deviation in compasses on iron ships, we take the following directions for effecting the compensation of the compasses. In order to avoid the employment of large masses of iron, it is best to use two iron rods placed diametrically opposite to each other. To determine exactly the distance of these rods from the centre of the compass, it is best to turn the ship's head toward that point in the horizon at which the quadrantal deviation is a maximum, after first allowing for the semicircular deviation; then, by moving the rods to or from the centre of the compass, to annul the maximum quadrantal deviation. This error being thus compensated, it will be found that a portion of the rolling or heeling deviation is also removed. The semicircular deviation is then best compensated, by means of two magnets, as follows: Under the centre of the compass is fastened a non-magnetic metallic parallelopipedon of square section, one side of which is parallel to the keel; the lower side of this should be fastened to a metallic disk of the same material, and this so fastened by screws to the base of the binnacle that its position can not be altered with reference to the keel of the vessel. On the upper end of this parallelopipe-

don must be fastened a cross-piece, by means of which the whole may be kept always vertical. A steel magnet is provided with a square slit, such that it can be placed any where and in any position upon the parallelopipedon. According, then, as certain co-efficients in the expression for the magnetic disturbance are larger or smaller, the magnet is to be placed either parallel or transverse to the parallelopipedon, and is to be moved up or down until the needle points accurately north and south, when the magnet is to be fastened in that position. The ship is then to be swung, and a third magnet is also to be fastened to the same parallelopipedon in a certain manner described by Garbich, until when the ship heads east and west the needle still points correctly north and south, when this third magnet is to be fastened in its place. With this adjustment the correction of the compass is finished, except in so far as there may still remain a slight error, due to the want of symmetry in the apparatus, and which may be corrected by swinging the ship to the west as well as to the east. In order to compensate for the remaining rolling or heeling deviation, a cylindrical steel magnet, about seven inches long and two thirds of an inch thick, is appropriate, which is to be placed before the needle and inclined to the vertical, at an angle whose tangent is a well-known co-efficient. This compensation becomes of great importance in high latitudes. In passing into magnetic southern latitudes, the vertical compensating magnet must be reversed end for end. The easiest method of directing the ship toward any given point of the horizon will be attained by the use of a compass described by Garbich, combining in itself both magnetic and azimuthal compass, having three concentric azimuthal circles, and which is to be used in connection with the azimuthal tables computed by Labrosse, which give, for every latitude of the ship and every position of the sun, and for every hour of the day between sunrise and sunset, the angle between the meridian and the sun's vertical. — "*Mittheilungen*" *Austr. Hydrog. Office*, 1874, 167, 257, 426.

ANCIENT MUSICAL INSTRUMENT IN CHINA.

Among the ancient musical instruments of the Chinese is the pien king, which is an assortment of sixteen stones ar-

ranged on strings in two series of eight each, one above the other, and each giving out, when struck successively, the system of sounds employed by the ancient Chinese in their music. The size and shape of these stones have been very carefully determined by them after a minute analysis of the sounds peculiar to each one. In order to render the sound graver, the thickness of the stone is diminished to the proper amount, and, to render it more acute, something is cut off from the length. The stones thus arranged remind one in effect of a series of steel bars, as exhibited in acoustic apparatus to illustrate the fact that vibrations above a certain pitch are inaudible to the human ear. Frequent endeavors have been made to decide what kind of stones were employed in the fabrication of the pien king, since they were customarily paid as tribute money more than two thousand years before Christ by certain provinces of China. Certain authors have thought that they recognized in them a kind of black marble; and the editor of the works of Father Amiote asserts that the king, or musical stone, constructed in France from the black marble of Flanders, was quite as sonorous as those of China. Lately a discovery was made at Kendal, in England, of some musical stones, which, when struck with a piece of iron or another stone, gave out sounds of very different pitch, and with eight of which it would be possible to attain a very distinct octave.—13 *B*, III., 203.

REMARKABLE IMPROVEMENTS IN STRINGED INSTRUMENTS.

Some very remarkable results of persistent investigation have been just communicated to the Physical Society of London by Mr. Hamilton, of Oxford. In prosecuting these researches Mr. Hamilton has for over two years resigned all other work, and he announces finally that, by means of stringed instruments reinforced by reeds, he has been able to secure for these all the advantages of organ pipes, in addition to those which they already possessed. In short, the strings vibrating on the sounding-board are made to imitate exactly in volume, quality, and sustained sound either an open diapason pipe or the largest organ pipe in use, his hearers being satisfied that not only can a string do all the work of an organ pipe in volume and sweetness, but also afford the exquisite sympathetic and blending power hitherto con-

sidered to be peculiar to strings. Another invention of his is a string which, to the great surprise of those who attempted it, could not be put out of tune. Mr. Hamilton is still engaged in perfecting his inventions, which promise to give us the effect of an organ in a piano-forte, and that of a piano-forte in a cottage instrument.—12 *A*, XI., 99.

HARMONY IN MUSICAL INSTRUMENTS.

In a course of lectures on the science of music Mr. Ellis has explained the defects of the ordinary keyed instruments, toned by a system which he characterizes as the worst possible, in that every element of harmony is violated. In the piano-forte the errors of temperament are not so offensive as in the organ and in the harmonium. In olden times organs were tuned on a temperament which put the principal keys in good tune, but more recently organists, having made up their minds to play in all sorts of remote keys, a great change has taken place, and an equal temperament has been attempted. For show organs this course may be defended, but not for church organs, where nothing but the simplest keys are required. The organ of half a century ago was a sweet-sounding instrument compared with the harsh ones of modern days. A curious proof occurred a few years ago of the mischief done to the tone of an organ by the equal temperament. Dr. Pola had to construct two organs of tolerable size. In the one he gave way to popular prejudice by having it tuned equally; in the other he adopted the old tuning; and though the instruments were precisely alike in other respects and made by the same builder, the latter organ acquired the reputation of being peculiarly sweet-toned, while the former was considered harsh.—12 *A*, XI., 89.

D. CHEMISTRY AND METALLURGY.

VANADIUM IN ROCKS.

Vanadium, hitherto regarded as one of the rarest metals, is now said by Dr. A. A. Hayes to be very widely diffused. It occurs as vanadic acid, associated with phosphoric acid, in minute traces in very many of our commonest rocks. In fact, it seems to be almost as frequently met with as manganese. Dr. Hayes has detected it in green and plum colored slates and porphyries, in sandstones, and in various rock aggregates.—1 *A*, *April* 16, 1875, 166.

CRYSTALLIZED CADMIUM.

Hermann Kämmerer has obtained fine crystals of metallic cadmium by distilling the metal in a current of hydrogen in a combustion tube. These crystals were silver white, and seemed to belong to the regular system, there being regular octahedrons, dodecahedrons, and other more complicated forms. The experiment can be performed in the lecture-room before a class.—21 *A*, *May*, 425.

OXIDATION OF RUTHENIUM.

Ruthenium, the rarest metal of the platinum group, differs from its associates in the ease with which it undergoes oxidation. Its properties in this respect have recently been investigated by Deville and Debray, who worked chiefly with the tetroxide, RuO_4. This substance is easily formed by the fusion of ruthenium before the oxyhydrogen blowpipe. The metal then oxidizes almost as readily as antimony, giving off a blackish vapor which smells strongly of ozone. Strangely enough, however, the oxide, although formed at such a high temperature, can not be heated without decomposition. By simply heating a specimen of it to about 108° Centigrade, it can be made to decompose with a very violent explosion, yielding a large quantity of highly ozonized oxygen. These peculiarities seem to distinguish it from all other known oxides.—*Annales de Chimie et de Physique*, *April*, 537.

METALLIC BARIUM.

Although the compounds of barium have been so long and so thoroughly known, the metal itself has been but little studied. Sergius Kern, of St. Petersburg, has lately succeeded in preparing it by several methods in a state suitable for examination. The best process seems to be to heat barium iodide with metallic sodium. A violent reaction ensues, accompanied by an evolution of heat and light; the resulting mass is treated with mercury to form a barium amalgam, from which, finally, the mercury is distilled. The barium so obtained resembles calcium very closely, is apparently tough and ductile, and has a specific gravity of 3.75.—1 *A, June* 4, 243.

PURIFICATION OF TIN BY FILTRATION.

Curter has proposed an interesting method of freeing tin from less fusible metals by means of filtration. The filter was constructed as follows: Common tinned iron of ordinary thickness was cut into strips about 150 millimeters long by 100 wide. Five hundred of these, with their surfaces parallel, were wedged together in an oblong iron frame, and this frame was tightly fitted into an opening in the bottom of a large graphite crucible. The tin to be purified was then melted in another crucible, and allowed to cool until crystals began to form on its surface, when it was transferred to the above-described filter. Of course the heat sufficed to melt the tinning of the iron strips, thus leaving narrow spaces between them through which the molten metal could flow, its solid impurities remaining behind. More than fifty centners of impure Bohemian tin was thus rendered almost chemically pure, the iron, copper, and arsenic with which it had been contaminated being left, alloyed with some of the tin itself, upon the filter.—14 *C, March,* 469.

THE ARTIFICIAL IMITATION OF NATIVE MAGNETIC PLATINUM.

It is known that occasional pieces of native platinum not only act upon the magnetic needle, but are themselves magnetic, like the true iron magnets. Berzelius and Kokscharof have contributed somewhat to our knowledge of the chemical and other properties of this platinum, and have shown that there is always a certain quantity of iron associated in

these specimens, so that Breithaupt has proposed for it the name of iron-platinum. The subject has recently undergone a very thorough study by Daubrée, who from his experiments upon the native material shows that the presence of iron in proper proportion suffices to account for the polarity of the native specimens. He still more firmly establishes his conclusions by artificially producing magnetic platinum, similar to that which occurs in nature. An alloy of 99 parts of iron and one of platinum, after a complete fusion, instead of becoming strongly magnetic, did not give any trace of polarity. Two other alloys, of 75 and 50 parts of iron respectively, behaved in very nearly the same manner. Alloys formed some time ago by Berthier, containing 78 parts of platinum and 21 of iron, although imperfectly melted, are, however, susceptible of magnetism. It appears, then, that however pronounced may be the magnetic power of the iron, the alloys where this metal predominates do not acquire polarity under the same conditions as do alloys obtained with a smaller quantity of iron. Thus an alloy of 17 parts of iron and 83 parts of platinum has very strong magnetic properties, so that we must admit that platinum alloyed with iron in proper proportions becomes exceptionally susceptible of acquiring the magnetic state. In nature this magnetic state would naturally be produced by strong induction, attributable to the magnetic forces of the globe; and Daubrée has therefore, as a last experiment, placed a small bar of the alloy during its fusion exactly in the plane of the magnetic meridian. As soon as it was solidified, it was inclined so as to be parallel to the inclination needle, until its cooling was complete, and it was then recognized that the bar actually presented at its two extremities very energetic magnetic poles, the upper end being the south pole of the needle, showing that the earth's magnetism had actually produced this effect. On heating the same bar to a red heat, and giving it the diametrically opposite position during its cooling, it was found that the magnetism of the bar was reversed by the earth's induction.—*Bulletin Hebdomadaire*, XVI., 40.

PRECIPITATION OF METALS BY ZINC.

Every chemist knows that when metallic zinc is placed in a solution of either copper or silver, the latter metal is pre-

cipitated. J. L. Davies has found it to be possible to precipitate nickel in a similar manner, it being necessary, however, to render the nickel solution strongly ammoniacal. The zinc is used in the form of filings, and the nickel is thrown down distinctly metallic and in a weighable condition. The experiments were made with solutions of the sulphate and the chloride of nickel.—21 *A*, *April*, 311.

ABSORPTION OF HYDROGEN BY METALS.

Not long ago Troost and Hautefeuille announced that sodium, potassium, and palladium absorbed hydrogen to form alloys of definite composition. They now present the results of similar investigations with iron, cobalt, and nickel. These metals absorb hydrogen largely, but to different degrees under different circumstances, not forming genuine compounds. Thus an ingot of nickel under favorable conditions will absorb one fifth its volume of the gas. The same metal in an electrolytic film can be made to take up forty volumes, while pulverulent nickel can dissolve nearly one hundred times its bulk of hydrogen. With each of the three above-named metals the pulverulent or pyrophoric modification has the highest absorptive power, and the compact form the lowest. Finely divided iron was found to differ from cobalt and nickel in its power of decomposing water, a phenomenon which takes place slowly at ordinary temperatures, and rapidly at about 100° Centigrade. Iron thus resembles manganese more closely than either of the other metals.—6 *B*, *March* 29, 788.

OZONE IN THE LIBYAN DESERT.

Professor Zittel, during a recent journey in the Libyan Desert in Egypt, made some observations of atmospheric ozone, from which it appears that the air over the desert is richer in ozone than that at the oases and the valley of the Nile, the ratios being as 73 to 48. The Libyan Desert, therefore, seems to be the richest in ozone of all portions of Europe. The ozone was observed to be always less in the daytime than in the night—greatest during clear weather and with northwest or west winds. Vegetation has been generally looked upon as an important source of ozone, whereas Ebermayer says that in all wooded regions the air in winter

is richer in ozone than in summer, and that therefore forests, as such, evidently do not exert any influence through their leaves, but possibly through their greater moistness. Zittel, however, thinks there is no relation between vegetation and atmospheric ozone.—*Zeitschrift für Meteorologie*, IX., 312.

THE PHYSICAL PROPERTIES OF HYDROGENIUM.

The interesting substance known to chemists as hydrogenium has been the subject of some physical measurements by Dewar, who has attempted to make a new determination of its specific heat and its co-efficient of expansion. The only condition under which hydrogenium is known to exist is that of an alloy with the rarer metals, palladium, platinum, etc. As the result of his experiments with palladium and hydrogen, the specific heat of hydrogenium is concluded to be almost exactly 3.4. The co-efficient of cubical expansion appears to be very nearly 0.00025.

THE COMBUSTIBILITY OF IRON.

The following elegant lecture experiment for illustrating the combustibility of iron was originated by the late Professor Magnus, of Berlin. A mass of iron filings is approached by a magnet of considerable power, and a quantity thereof permitted to adhere to it. This loose, spongy tuft of iron dust contains a considerable quantity of air imprisoned between its particles, and is therefore, and because of its comminuted condition, well adapted to manifest its combustibility. The flame of an ordinary spirit-lamp or gas-burner readily sets fire to the finely divided iron, which continues to burn brilliantly and freely. By waving the magnet to and fro, the showers of sparks sent off produce a striking and brilliant effect.

NEW METHOD FOR ASSAYING IRON.

W. N. Hartley recommends a new and beautifully simple method of assaying iron ores, in which the only apparatus needed is a balance *without weights*, and a burette. To begin with, a quantity of pure iron wire is taken (about five grammes), and balanced by a sample of the pulverized ore. The ore and wire are then separately dissolved, and each solution titrated in the usual manner by permanganate

of potash. Then, to get the percentage of iron in the ore, the following simple calculation will suffice: $\frac{100m}{n} = x$. Here m and n are the quantities of permanganate solution used respectively for the ore and the wire, and x is the value sought. The method gives remarkably accurate results, even in the hands of beginners.—21 *A*, *May*, 410.

TO DETECT LEAD IN THE TIN LINING OF VESSELS.

The following simple test may be found of great service where it is desired to determine the presence of lead in vessels used for canning fruit, etc. M. Fordos directs that a carefully cleansed portion of the lining should be touched with a drop of nitric acid, whereby both metals (if present) are oxidized, the tin to stannic acid and the lead to nitrate of lead. By slowly heating the acid will be driven off, when the spot is to be touched with a drop of solution of iodide of potassium. If lead is present the spot will turn yellow by the formation of iodide of lead. The iodide has no action upon tin.—6 *B*, XII., 1875.

UTILIZATION OF THE PYRITE DEPOSITS OF THE BLUE RIDGE.

Professor T. Sterry Hunt, in a recent communication to the New York *World*, reiterates the views upon this subject which he advanced some two years ago at the Portland meeting of the American Association. He then proposed to utilize the pyrite deposits of the Blue Ridge as a source of sulphuric acid, with which to convert into fertilizers the phosphates of South Carolina on a large scale. Certain objections having been made to this proposition upon economical grounds, Professor Hunt reviews this side of the question, and places it in a very favorable light. He argues that with easily accessible beds of a high grade of pyrite or sulphur ore, like that of Spain, we might compete successfully with Sicilian sulphur, even if this were free from duty. Of this pyrite, which contains a small percentage of copper, Great Britain imports and consumes about 400,000 tons annually. The acid from this ore serves for the greater part of her soda and fertilizer manufacture; and having thus utilized the sulphur, she extracts from the residue by solution several thousand tons of copper, leaving behind a nearly pure

oxide of iron, which is itself consumed in the puddling and blast furnaces. In view of these facts, Professor Hunt hopes to see a similar use made of the great deposits of pyrite, rich in sulphur and often in copper, which abound in the Blue Ridge in Virginia, North Carolina, and Tennessee. Large quantities of these ores are now being treated for the manufacture of copper at Ducktown, Tennessee, and at Ore Knob, North Carolina; and many other points in this region, in the opinion of Professor Hunt, are destined to become the seats of an important copper industry. It therefore becomes a question how those ores which are richest in sulphur may be most advantageously brought into contact with the abundant phosphates of the South Carolina seaboard. The extraction of copper as a secondary product from these ores will enable us to make acid cheaply, and to supply cheap fertilizers to the cotton-fields of the South. The fear having been expressed that these ores might contain notable quantities of arsenical compounds, Professor Hunt asserts them to be quite as free from this impurity as the Spanish ores so largely utilized in England. Upon this point, he furthermore remarks, the exceeding rarity of arsenical compounds in this region was long ago pointed out as a significant fact by Professor Henry Wurtz, of New York, in a paper "On the Cobalt and Nickel Ores of North and South Carolina," in the *American Journal of Science* for 1859; and this is confirmed by the experience of those who have been familiar with the metallurgical treatment of the pyritous ores of Ducktown and of Ore Knob, already mentioned.

NEW VIEWS OF CHEMICAL AFFINITY.

Dr. E. J. Mills has made an interesting application of principles first evolved by Esson to some observations made by Dr. Gladstone, and published in 1855 in his work entitled "Circumstances Modifying the Action of Chemical Affinity." Mr. Esson had in fact shown that when a substance undergoes chemical change, the process takes place at a rate that has a relation to the mass of the substances acting upon each other at any given moment during the process, and the relation between the time and the quantity of the chemical still unchanged at any moment may be expressed either by a complex analytical formula or by a logarithmic curve. This

equation, which may be called Esson's equation, on being applied to the numerous exact observations recorded by Gladstone, leads Dr. Mills to the conclusion that 54 per cent. of the discordances between the theory and the observations are such as would on the average be found in any very good analytical work, 33 per cent. occur in ordinary good analytical works, and the remaining 13 per cent. lie on the average within the limits allowable in such estimation of colors as Dr. Gladstone made. The ordinary equations of chemistry represent the result of distributing atomic weight, and give no account of the work done. Esson's equation and conclusions worked out by Gladstone, on the contrary, represent a dynamic process as well as the distribution of weight.—7 *A*, XLVIII., 246.

WATER OF CRYSTALLIZATION.

Professor Guthrie states that the absorption of heat, which occurs when the salt is dissolved in a liquid, depends not only on the relative specific heat of the salt in the liquid, but also on the molecular ratio of the resulting solution. This ratio declares itself, first, optically by the refractive index; second, by the density; third, by the heat absorbed when a saturated solution is mixed with the medium; and, fourth, by the heat absorbed when the salt itself was dissolved in a certain quantity of the medium. The conclusion which he draws from his observations is that every salt soluble in water is capable of uniting with water in a definite ratio, forming definite solid compounds of distinct crystalline forms and constantly melting and solidifying temperatures.—12 *A*, XI., 59.

VIDAL'S APPARATUS (EBULLISCOPE) FOR THE DETERMINATION OF THE AMOUNT OF ALCOHOL IN WINE, ETC.

The following instrument, an improvement on that originally devised by Vidal, it is claimed will indicate accurately the percentage of alcohol in liquids in less than ten minutes, using but little of the liquid. It depends upon the fact that sugar, resin, citric and tartaric acids do not change the boiling point of alcohol in which they may be dissolved, and consequently the determination of the boiling point will show the amount of alcohol present in an aqueous liquid. It consists of a conical boiler, closed at the top with a screw-cap

having two apertures in it, through one of which a thermometer, bent at right angles, is inserted, in such a way that the bulb can be immersed in the liquid or the vapor at pleasure, while upon the other is screwed a condenser, consisting of two concentric cylinders. At diametrically opposite points at the bottom of the boiler the ends of a small curved spiral-shaped tube are inserted. This tube, filled with the same liquid as the boiler, passes directly through the chimney of a lamp, and consequently receives upon a small surface the whole of the heat of the lamp. The fluid, thus gradually warmed, circulates through the tube and the boiler, until the whole of it has reached the boiling point, when the thermometer becomes stationary, and will remain so for ten minutes. A horizontal movable scale is fixed to the top of the boiler, by comparing which with the thermometer the amount of alcohol is indicated in degrees from 0 up to 25.—14 *C*, CCXIII., 87.

SPECIFIC HEAT OF CARBON, BORON, AND SILICON.

In 1819 Dulong and Petit discovered that when the specific heat of a solid element was multiplied by its atomic weight, the product was a constant quantity in the neighborhood of 6. Later, however, it was found that carbon, boron, and silicon were apparent exceptions to this rule. These elements have been studied in this direction by many experimenters with very discordant results; as, for instance, some found that the different modifications of carbon had the same specific heat, others that they varied widely. The subject has lately been thoroughly worked up by Dr. H. Friedrich Weber, whose results at last seem to be conclusive. Carbon he examined as diamond, graphite, coal, and charcoal, and boron and silicon in their crystalline varieties. His experiments were conducted at temperatures varying from —80° to +1000° Centigrade, and with the finest modern apparatus. With all three of the elements above named the specific heat increases very rapidly with the temperature. At 600° for carbon and boron, and at 200° for silicon, this increase almost ceases, and the specific heat remains nearly constant. Below 600° the different modifications of carbon give different results, but at and above this temperature they coincide. The constant final values, at the temperatures

above named, for the specific heats of the three elements are as follows: carbon, 0.46; boron, 0.5; and silicon, 0.205. These numbers, multiplied by the atomic weights, give values in accordance with Dulong and Petit's law, so that carbon, boron, and silicon can hereafter be regarded as exceptions only at low temperatures. Dr. Weber's extremely valuable paper concludes with some speculations, based upon his results, as to the nature of carbon, which he thinks may after all prove to be not an element, but a compound.—7 *A*, *March and April*, 1875, 161, 276.

A HYDRATE OF CARBON.

Whether or no any true hydrate of carbon can exist has long been an open question. It is now settled affirmatively by Schutzenberger and Bourgeois. These savants treated white cast iron in coarse powder with a solution of copper sulphate, and subsequently with ferric chloride and hydrochloric acid. The metal was thus entirely removed, and a pulverulent, blackish-brown body in small quantity remained. This body was found to be a hydrate of carbon containing eleven atoms of carbon united with three molecules of water. Nitric acid attacked it energetically, changing it into a reddish-brown amorphous substance, which proved to be a new acid of somewhat complicated structure. To this acid the discoverers have given the name nitrographitoic. It also seems to be formed by the direct action of nitric acid upon cast iron.—*Bulletin de la Soc. Chimique*, *May* 5, 387.

CRYOHYDRATES.

Frederick Guthrie, in a paper upon "Salt Solutions and Attached Water," has described a curious new series of compounds, which he terms "cryohydrates." He finds that when any saline solution is exposed to a freezing mixture, a crop of crystals after a while separates out, containing the salt plus a definite quantity of water. Thus a saturated brine affords crystals containing one molecule of common salt united with ten molecules of water. Sulphate of zinc, under similar circumstances, forms a cryohydrate with twenty molecules of water; magnesium sulphate with twenty-four molecules, saltpetre with forty-four, sodium sulphate with one hundred and sixty-six, and so on. Similar cryohydrates

are produced with alcohol or with ether in place of a salt. The most important practical feature of Mr. Guthrie's discovery, however, lies in its applicability to the production of constant, low temperatures. As is well known, water, when passing from the solid to the liquid state, remains steadily at 0° Centigrade until the change is complete. Just so each of these cryohydrates has a constant melting point which can be maintained in any mass of material until the whole is fused. The cryohydrates thus far examined command a range of temperatures from 0° to —28° Centigrade. In order to maintain a vessel at any temperature between these limits, it need merely be surrounded by the proper cryohydrate in a partially melted condition. Then, until either complete fusion or complete solidification of the cryohydrate has occurred, the temperature can not vary.—7 *A*, *January*, *March*, *and April*, 1875, 1, 206, 266.

DECOLORIZING PROPERTIES OF OZONE.

M. Boillot ascribes the bleaching effects, heretofore credited to chlorine, as being really due to ozone. Ozone, employed directly, acts as an oxidizing agent, laying hold of the hydrogen of the substance with which it is in contact, and bleaching it if the body is colored. The action of chlorine the author explains as follows: On allowing chlorine to act upon any animal or vegetable matter, it decomposes a certain quantity of water, and seizes its hydrogen, forming hydrochloric acid. The oxygen set free by this reaction is transformed into ozone, which in its turn lays hold of the hydrogen of the organic matter.—6 *B*, *May* 3, 1875.

NEW FACTS CONCERNING OZONE.

Professor Böttger has succeeded in demonstrating that not only during the decomposition of water, but also on its formation by the union of oxygen and hydrogen, appreciable quantities of ozone are generated. In this connection we recall the fact announced several years ago by Dr. Pincus that ozone is formed during the burning of hydrogen, and that if a jet of this gas issuing from a fine point is ignited, the smell of ozone can be distinctly recognized. In close connection with both of these observations, however, is the discovery previously made by Mr. Loew, and since patented by him,

that ozone may be obtained in sufficient quantity for lecture-room demonstration and other purposes by simply blowing the heated air in contact with the margin of an ordinary Bunsen gas flame, with the aid of a glass tube, into a suitable receiver. If the product thus obtained is then tested with one of the ordinary reagents used for detecting ozone—viz., iodide of potassium, acetic acid, and starch—the blue coloration of the iodide of starch at once appears. At the time Loew's announcement met with some objectors, who sought to explain the phenomenon by assuming that the subsequent reaction was to be ascribed to the formation of small quantities of partly oxidized nitrogen products formed during combustion. The subsequent discoveries of Pincus and Böttger, however, appear to have settled the question by confirming the conclusion of Loew.

CARBONIC OXIDE IN TOBACCO SMOKE.

Dr. Krause has found that tobacco smoke contains a large quantity of carbonic oxide, and he attributes the injurious after-effects of smoking to this poisonous gas, some of which necessarily descends to the lungs, and produces more or less injury. According to Krause, the after-effects are more potent the more inexperienced the smoker, and he ascribes to the carbonic oxide the unpleasant results of the first attempts at smoking rather than to nicotine alone.—12 *A*, *April* 6, 1875, 456.

MELLILOTOL.

Dr. T. L. Phipson publishes an account of what he calls mellilotol, as being an acid oil slightly soluble in water, soluble in alcohol and ether, and transformed into mellilotic acid by the action of potassa. It is endowed with most fragrant odor—that of new-mown hay. He obtained it by the distillation of *Mellilotus officinalis* with water, and isolating from the distillate by means of ether. The plants may be gathered while in full bloom, those growing in sheltered places and flowering in August being richer in product. About 0.02 per cent. of pure mellilotol was obtained from the dried plant by distilling the stalks, leaves, and flowers together.

Mellilotol, according to Dr. Phipson, is the starting-point

of a great variety of very interesting compounds, and it yields, as before stated, mellilotic acid, which in its turn yields coumarin. It is mellilotol, and not coumarin, which is the cause of the odor of new-mown hay and of that of the flowers of the *Mellilotus*.—1 *A*, *July* 16, 25.

MANUFACTURE OF ARTIFICIAL VANILLA.

It is not long since Messrs. Tiemann and Haarmann, students of Dr. Hofmann, of Berlin, made the discovery that vanillin, or the aromatic principle of the vanilla bean, can be obtained from the sap of the pine. These gentlemen have now completed their operations for going into the manufacture of the article on a large scale, as they find that the sap of an ordinary tree will furnish vanillin of the value of $20, without in the least injuring the wood for timber. Dr. Hofmann, in communicating these facts to the Academy of Sciences of Paris, remarks that this is the second vegetable product manufactured by purely chemical methods.—12 *A*, *September* 24, 1874, 427.

HYDROGENIZED IRON.

Cailletet states that in his experiments on the passage, at ordinary temperatures, of hydrogen through iron, he has found that on allowing sulphuric acid to act upon a plate of iron, the hydrogen is, in part, absorbed by the metal, and that, by employing a system formed of two plates of iron soldered side to side, he finds the tension of the gas which accumulates in the apparatus is equal to a column of mercury 0.35 millimeter high. As the result of his investigations into this combination of iron and hydrogen, he says that this iron gives up, under water or other liquid, numerous bubbles of a gas which is pure hydrogen. In the open air the galvanic iron loses only a part of the hydrogen which it has occluded. When a piece of hydrogenized iron is brought near a burning body the hydrogen is rapidly disengaged, and the metal is surrounded by a light-blue flame. When the iron has lost by heat the hydrogen which it contained, one can not restore that gas to it. Employing a piece of iron that had been so heated as a negative electrode, Professor Cailletet found that the water is decomposed and the hydrogen disengaged as usual in abundance;

but the hydrogen does not again become occluded in the iron plate. Hydrogenized iron can be easily pulverized, but after it has been heated it retains a certain ductility. Hydrogen, in associating itself with the iron, communicates to it considerable magnetic force, so that the presence of hydrogen in iron modifies greatly the magnetic properties of this metal.

MICROSCOPIC EXAMINATIONS OF THE PROCESS OF CRYSTALLIZATION.

Professor Frazer, Jr., exhibited to the Academy of Natural Sciences of Philadelphia a combination of the polarizer, vertical lantern, and microscope, by means of which the manner in which different salts crystallize out of their solutions, together with the manner in which they affect polarized light, can be explained and illustrated. The light from a lime lantern is passed through a rubber tube polarizer, then upward through the vertical lantern and a two-inch lens microscope, when it is again reflected horizontally on the screen. He explains that while this method has the advantage of so magnifying the crystals produced from small quantities of solutions that their structure can be minutely observed, as well as the sudden molecular change which causes the polarizing effect, it is open to the objection of a very large loss of light, first by the polarizer, and again by the microscope. A part of this difficulty, however, can be obviated by the use of the parabolic reflector.—*Proc. Acad. Nat. Sci., Phil.*, 1875, 16.

A BRITTLE ALLOY OF IRON AND HYDROGEN.

Mr. Johnson communicates to *Nature* some important observations in reference to the action of hydrogen on iron and steel. Experiments made by him have shown that any acid which gives off hydrogen, when it is allowed to act upon iron or steel, produces the same effect, viz., of depriving the metal of its original toughness, and gives it the property of frothing when moistened with saliva. The gas coming off the surface of the iron, if cold, is shown to be hydrogen; and it seems probable that the brittleness of the metal is due to the occlusion of hydrogen within the iron. The simplest way of charging a piece of iron with hydrogen

is by laying it on a sheet of zinc in a basin of diluted sulphuric acid. The hydrogen generated by the action of the acid on the zinc is given off on the surface of the iron; and two minutes or less will suffice to charge a piece of iron with hydrogen, and alter its properties completely. This alteration is not confined to a diminution of toughness, which may be reduced to one quarter of its original value, but is also accompanied by a marked decrease in tensile strength, amounting in cast steel to upward of twenty per cent.; but in the case of iron-ware to only six per cent. The electrical resistance is increased by this occlusion of hydrogen. It is probable that repeatedly rusting iron occludes hydrogen, and it is thereby deteriorated in strength and toughness.—*Nature*, II., 903.

THE COMPOSITION OF BLEACHING-POWDER.

The question of the composition of the so-called "chloride of lime" has lately been much agitated. The generally received view of Gay Lussac, that it is a true calcium hypochlorite, has been attacked by Goepner, who regards it as merely a molecular compound of lime and chlorine, containing no hypochlorous acid. Mr. Ferdinand Kopfer now submits the subject to the test of a long series of careful experiments, and decides in favor of the old view. He finds that when a dilute mineral acid, just sufficient to saturate the calcium present, is added to a solution of bleaching-powder, no smell of free chlorine can be detected, but only the characteristic odor of hypochlorous acid. The solution thus obtained, shaken up with a large excess of mercury, yields the brown oxychloride of the metal, again proving the presence of hypochlorous acid.—*Jour. Chem. Soc.*, *August*, 1875.

THE INCOMPLETE COMBUSTION OF GASES.

The habilitation thesis of Dr. Ernst Meyer on the incomplete combustion of gases contains the following suggestive sentences: The studies upon inflammability, which, according to the experiments contained in this essay, stand in a closer connection with the phenomena of affinity than we should at first suspect, indicate the importance that must be attributed to the thermal relations of the gases. The combustion of carburetted hydrogen in a closed tube, which, be-

ginning with the overleaping of the limits of inflammability, and with increasing quantities of oxygen, exhibits a series of different steps, until finally, by its total combustion, we reach an invariable final result, exhibits many interesting passages. Simple as is the result of the complete combustion, the incomplete combustion is exceedingly complex. If a mixture of carburetted hydrogen with oxygen approaches the limit of inflammability, then, in general, the steps of the combustion are exceedingly complicated. In this case the strong affinity of carbon for oxygen is shown, in that the latter at first serves exclusively to form carbonic oxide. When the hydrogen begins to take part in the burning, then there becomes evident, as we recognize from the compound nature of the resulting mixture of gases, an effort to establish an equilibrium according to the properties of the molecules. Similarly, under simpler conditions, in the case of the incomplete combustion of a mixture of carbonic oxide and hydrogen, the burning gases arrange themselves according to their molecules; and the same regularity holds in the complicated processes of the combustion of carburetted hydrogen, while in the latter the play of the affinities of carbon and hydrogen in general is easily recognized. Although we can not obtain clear views concerning their relative proportions, still the observations which are here given form definite starting-points for further considerations. These simplest processes will, perhaps, assist in the solution of problems of the highest importance in the mechanical explanation of the phenomena of chemical affinity. Precisely those conditions which variously affect the affinity of hydrogen and carbonic oxide, and which, as we may assume, may be referred to the different friction of the gases, point to causes which must be sought in the moving molecules themselves. A thorough study of such modifying circumstances will certainly advance our knowledge of the nature of chemical affinities.—*Habilitations Schrift, Leipzig*, 1874.

GASES OCCLUDED IN METEORITES.

The meteorite that fell on the 12th of February, 1875, in Iowa, has been examined chemically by Professor Wright, of New Haven, who has shown that in the gases contained

within it there was a great predominance of the carbon compounds, which were plainly indicated by spectroscopic analysis; and by careful quantitative analysis it was found that 49 per cent. of the occluded gases were carbonic acid and carbonic oxide; the residue consisted largely of hydrogen. This meteorite is of the stony kind, in which the oxides of carbon are the characteristic constituents, while in the iron meteorites hydrogen is most abundant. The spectrum of the gases evolved from this meteorite, at a few millimeters' pressure, gave brilliant carbon bands; the brightest were the three in the green and blue, the red only being much feebler; agreeing in this respect remarkably with the spectrum of some of the comets, and affording a decided confirmation of the received theory as to the meteoric character of those bodies.—4 *D*, III., x., 44, *July*, 1875.

SOURCE OF THE ACID OF THE GASTRIC JUICE.

The theories which have been proposed to account for the acidity of the gastric juice agree that this acidity is due to hydrochloric acid; but they differ as to the mode of its production. One theory supposes that the chlorides of the food are decomposed by the lactic acid which results from the decomposition of the carbohydrates ingested; the other that these chlorides are decomposed by simple dissociation. To test these theories, Maly has made a series of experiments, mainly upon dogs, but also upon the human subject. He confirms Bence Jones's observation that the acidity of the urine is diminished during the secretion of the gastric juice, being a minimum when the digestive process reaches its maximum activity. But as this fact may be accounted for on either theory—according to the first the lactates produced being oxidized to carbonates, and so entering the urine, and, according to the second, the dissociated alkali entering the urine directly—Maly sought to decide the question by ascertaining whether chlorides could be decomposed by lactic acid. Sodium chloride and lactic acid, when distilled, gave only at the last traces of hydrochloric acid. But diffusion experiments, in which lactic acid was mixed with sodium, calcium, magnesium, and ferrous chlorides, showed that hydrochloric acid was formed in dilute solutions. The question then recurred on the formation of lactic acid in the living stomach.

Fragments of the mucous membrane of the stomach of the pig were digested at 40° Centigrade with two per cent. solutions of grape sugar, cane sugar, milk sugar, and dextrin. Lactic acid was formed, but the process was stopped at 100° Centigrade. Gastric juice, however, used in place of the membrane, produced no such effect. From the fact that an abundance of bacteria were developed at the same time, Maly considered it quite clear that the formation of lactic acid results from an organized and not from a chemical ferment; and therefore that the production of lactic acid is not a function of a living membrane. This view is strengthened by the fact that the fresh stomach of a dog, when digested with a two per cent. solution of grape sugar, gave no acid until after two days. Moreover, the stomach of a living dog was emptied, milk of magnesia introduced, withdrawn after an hour, and the magnesia dissolved determined; then the sugar solution was introduced with the magnesia, and the experiment repeated. The same amount of dissolved magnesia was found in both cases, showing that the living membrane does not cause the formation of lactic acid from sugar. The author maintains, therefore, that free lactic acid is absent from gastric juice, and that hence, *à fortiori*, it does not decompose chlorides to set free hydrochloric acid. The source of this latter acid in the gastric juice the author believes to be dissociation.—33 *C*, CLXXIII., 227.

DECOMPOSITION OF CHLORAL HYDRATE IN THE SYSTEM.

It was assumed by Liebreich, the discoverer of the peculiar physiological action of chloral hydrate, that this substance, under the influence of the alkaline blood-serum, was decomposed, yielding chloroform. Tanret has shown, however, that if a solution of chloral hydrate be mixed with an alkaline solution of potassium permanganate, the liquid is decolorized, a gas is evolved, and manganic oxide is precipitated. If the quantity employed be considerable, and the temperature be kept from rising above 40° Centigrade, the reaction is slow, and the filtered liquid will be found to contain chloride, carbonate, and formate of potassium. The gas evolved is carbonous oxide. The same reaction can be effected in very dilute solutions, and takes place even when the alkalinity is produced by borax. From these data the

author proposes a new theory to account for the action of chloral hydrate in the animal economy. When taken into the body, it is not only submitted to the alkaline serum, but to oxidizing agencies at the same time. Both these causes taken together effect its decomposition in the manner above described, carbonous oxide being set free in the blood, displacing its oxygen and producing symptoms analogous to those observed in cases of poisoning by this oxide of carbon. Moreover, the lowering of the temperature of the body, which is observed in these cases, and the prolonged action observed with chloral hydrate, combine to render this hypothesis more tenable than the old one. Fatal poisoning by chloral hydrate is not at all an impossible thing, therefore, if these facts be true.—6 *B*, LXXIX., 662.

GALLIUM, A SUPPOSED NEW CHEMICAL ELEMENT.

Lecoq de Boisbaudran announced to the French Academy, on the 27th of August, that he had discovered a new chemical element in a blende from the Pierrefitte Mine, valley of Argèles, Pyrenees. Its chemical reactions resemble those of zinc, but it differs from this metal in being precipitated as oxide by zinc, and also by the following facts: That its chloride is precipitated by ammonia; that its oxide is soluble in an excess of ammonia; that its sulphide is precipitated by ammonium sulphhydrate, and is insoluble in excess of the precipitant; that this sulphide is thrown down in presence of acetic though not of hydrochloric acid; that barium carbonate precipitates it even in the cold; that the chloride is not volatile; and that when the solution containing zinc is heated up to the point of production of oxychloride, all of the new substance remains insoluble. In a subsequent paper presented to the Academy a month later, the author proposes the name *Gallium* for the new metal, and gives more complete statements of its spectroscopic characters. In concentrated solution, it gives with the electric spark a spectrum containing two prominent lines. One of these is a moderately bright violet line of wave-length 417. The other is fainter, and has a wave-length of 404. The chloride gives the line 417 in the ordinary gas flame.—6 *B*, LXXXI., 493, *Sept.*, 1875.

CONSTITUTION OF AMMONIUM AND ITS DERIVATIVES.

Valuable to the science of chemistry as the theory of equivalence has been, it has yet very much to do before it can be admitted to be complete. Indeed, the signs of the times point to a period not very distant when it will be merged into some higher and broader generalization. Chemists are not now agreed, for example, upon a point which would seem to lie at the very foundation of such a theory: namely, whether the equivalence of an element is a fixed quantity for that element, or whether it can vary. In the case of nitrogen, for example, all are agreed that it may and does act as a triad in ammonia; but in ammonium chloride, NH_4Cl, where it is combined with five monad atoms, all are not willing to concede that it is quinquivalent. Meyer and Lecco have sought to throw some light upon this question by a careful study of the compound ammoniums. If two of the four atoms of hydrogen in ammonium chloride be replaced by ethyl and two by methyl, two isomeric bodies can be formed if the nitrogen be a triad—thus $N(CH_3)_2C_2H_5+C_2H_5Cl$ and $N(C_2H_5)_2CH_3+CH_3Cl$; while, if it be a pentad, these bodies, prepared even though they be in different ways, must be identical. The former of the two was prepared from dimethylamine, and the latter from diethylamine; and the compounds themselves as well as their derivatives were subjected to the most careful scrutiny, but not the smallest difference could be observed between them. A critic having suggested that possibly a rearrangement of atoms within the molecule having taken place caused this similarity, the authors specially tested the matter, but with a negative result. They maintain, therefore, that the equivalence of nitrogen in ammonium is five, and that equivalence is variable.—35 *C*, VIII., 233, *March*, 1875.

WHY DOES PLASTER OF PARIS SET?

Landrin has examined the chemical and physical changes which are produced in the setting of plaster of Paris. He notices that three separate actions take place, and that these may very readily be observed under the microscope. They are: First, the burned plaster in contact with the water assumes a crystalline form. Second, the water which envel-

ops the crystals takes up in solution considerable calcium sulphate. Third, a portion of this water being evaporated by the heat resulting from the chemical combination, a crystal is formed which determines the crystallization of the whole mass, just as when a crystal of sodium sulphate is dropped into a supersaturated solution of that salt. It is not, however, until after some time that the mass acquires its maximum hardness, the plaster then containing the required proportion of water, *i. e.*, two molecules to one of the calcium sulphate. This amount of water does not lessen by evaporation. In mixing plaster, only about 12 per cent. of water should be added, as ordinary plaster itself contains about 8 per cent.; but in actual practice the amount used is never less than 33 per cent. This excess is added in order to prevent setting of the mass before it can be used. But the effect is injurious, since very porous, slowly drying plasters are produced in this way, which rapidly determine nitrification. To diminish the rapidity of setting is to delay the crystallization, which can be effected by adding gum, gelatin, guimauve powder, glycerine, and similar bodies. Inert substances, like sand and barium sulphate, for example, on the other hand, simply diminish the solubility of the material, without in the least retarding the setting process. Overburned plasters may be utilized by admixture with ordinary plaster, since the crystallization of the latter extends to the former, and occasions the setting of the entire mass. A similar effect is produced by simply mixing the two plasters together. Lime acts favorably upon plaster, as it not only increases the rapidity with which it sets, but it gives it an additional hardness. Plasters to which 10 per cent. of lime has been added are capable of taking a polish. Samples have been made containing as high as 75 per cent. of lime; they are hard and light, and may yet serve some useful purpose in the arts.—6 *B*, LXXIX., 658.

CONSTITUTION OF GUM TRAGACANTH.

Giraud has made a minute examination of the chemical characters of gum tragacanth. He finds (1) that this gum is but very slightly soluble in water, and that the product in the filtrate is not a definite principle like arabin, but is a mixture of several substances; (2) that digested on the wa-

ter-bath for twenty-four hours, with fifty times its weight of water, much of it is transformed into a soluble gum, which no longer swells after drying: this new substance is pectin; (3) that under the action of water containing one per cent. of acid, the production of pectin takes place in two or three hours. It becomes entirely soluble, and alcohol precipitates pectin, not arabin, from the solution. Alkalies change it into pectates and meta-pectates. Hence gum tragacanth consists for the most part of a pectic principle insoluble in water, apparently identical with Fremy's pectose. From it by precipitating the pectin solution by barium hydrate and decomposing by an acid, pure pectic acid was obtained. Upon analysis, gum tragacanth yields as follows: Water, 20 per cent.; pectic compounds, 60 per cent.; soluble gum, 8 to 10 per cent.; cellulose, 3 per cent.; starch, 2 to 3 per cent.; mineral matter, 3 per cent.; nitrogenous matters, traces.—4 *B*, III., v., 361, *April*, 1875.

CARBONYLES, A NEW CLASS OF ORGANIC BODIES.

Berthelot has recently instituted a new class of organic bodies, to which he has given the name *Carbonyles*, and to which he assigns three bodies hitherto rather ambiguous in their chemical behavior. These are allylene oxide, diphenylene acetone, and ordinary camphor, to which he gives the new names dimethylene carbonyle, diphenylene carbonyle, and terebutylene carbonyle. The distinguishing feature of carbonyles is their double function. In the first place they act like aldehydes, being able to fix hydrogen directly and to produce alcohols; while they are themselves reproduced, like aldehydes, by hydrogenization of these alcohols. Again, like aldehydes, they may be formed by the direct or indirect oxidation of hydrocarbons; camphene hydride and oxygen producing camphor precisely as ethylene hydride and oxygen produces common aldehyde. But, secondly, it is to be observed that while aldehydes are produced by the indirect oxidation of saturated hydrocarbons, carbonyles result from the indirect oxidation of unsaturated hydrocarbons. This is a very material difference, since, besides its aldehydic function, the carbonyle molecule is itself unsaturated for this very reason, and hence can combine directly with other saturated molecules. Like the radical carbonyl itself, from

which these bodies take their name, they can therefore fix directly the elements of water and form monobasic acids; dimethylene carbonyle uniting with water directly and yielding propionic acid. Moreover, by virtue of this unsaturation they can unite directly with three atoms of oxygen to form dibasic acids; camphor yielding camphoric acid in this way. Conversely, the removal of water and carbonic dioxide from a single molecule of a dibasic acid yields a carbonyle; thus differing from the analogous production of ketones, by the fact that in the latter case the removal is from two molecules of a monobasic acid. The author gives evidence to show that camphor belongs to this class of bodies, and says that, had he not hesitated to found a new class of bodies on a single compound, he would have proposed camphor as a carbonyle long ago.—*Bulletin de la Société Chimique de Paris*, II., xxiii., 146, *February*, 1875.

HÆMATIN NOT FERRUGINOUS.

It has been for some time known that the proportion of iron which existed in the coloring matter of the blood, called hæmatin, was very variable, and that by repeated purification it could be so far reduced in amount that only a trace remained. Hence the opinion has arisen that the iron is not an essential constituent, as is generally supposed. Paquelin and Jolly have examined the question at length, starting from the well-known researches of Chevreul upon this substance, which were to the same purport. The results have shown the correctness of the assumption, they having succeeded in devising a process by which the whole of the iron may be removed and the hæmatin obtained pure. In brief their method is as follows: Having removed the albuminates of the blood by basic lead acetate, the corpuscles are dried and powdered, then digested in glacial acetic acid until they are reduced to a gelatinous mass. The coloring matter is then taken up by carbon disulphide or benzene, and the hæmatin recovered by careful evaporation of the solvent. The corpuscles may with advantage be macerated in alcohol containing ten per cent. of ammonia previous to the treatment with acetic acid. The purification of the hæmatin from the iron is the next step. It is dissolved in ten times its weight of acetic acid, two and a half parts of citric

acid dissolved in a little water is added, and the whole is brought to boiling to favor the colution of the iron. To the cooled liquid, ammonia is added in quantity sufficient to exactly neutralize the acids, and the precipitated hæmatin allowed to subside. This treatment is repeated so long as ammonium sulphide discovers in the supernatant ammoniacal liquid any trace of iron. The purified hæmatin is finally dissolved in ether, the solution filtered, and the ethereal liquid allowed to evaporate spontaneously. The pure coloring matter is insoluble in water, slightly soluble in alcohol, but readily so in ether, chloroform, carbon disulphide, and benzene. It burns on platinum like a resinous substance, without leaving any trace of ash.—6 *B*, LXXIX., 918.

FORMATION OF SULPHATES BY GAS FLAMES.

A white incrustation is always formed after a short time on the glass covers hung over gas flames. This incrustation consists of small crystals of normal ammonium sulphate, with a trace of soda and potash. The sulphur in the gas which is burned to produce the sulphuric acid does not exist in the condition of hydrogen sulphide, but in that of carbon disulphide. The ammonia is not a product of combustion, for if a basin whose lower surface is moistened with hydrochloric acid be held over a gas flame, there are no fumes visible, and no ammonia is found even with the delicate reagent of Nessler. But unburned gas contains a small quantity of ammonia, enough to give a yellow color with the Nessler test. Priwoznick has investigated this question, and supposes that the ammonia comes from the nitrogen of the air, for Saussure has shown that ammonia is formed when hydrogen is burned in oxygen containing nitrogen. Schönbein proved the presence of ammonium nitrate in the products of combustion of fat and of coal-gas. The carbon disulphide in the gas would burn to carbonic and sulphurous dioxides. But sulphurous oxide can not exist in presence of ammonium nitrite, but is immediately oxidized to sulphuric acid and combines with the ammonia. The glass cylinder of an argand lamp is also often covered with a white incrustation. This consists mainly of potash, soda, lime, etc., from the ash of particles of dust in the air.—14 *C*, CCXIII, 223.

ON A NEW COLORING MATTER CALLED EOSIN.

In 1871 Baeyer observed that when pyrogallol was heated with phthalic oxide under such circumstances that water was abstracted, a peculiar body resulted, which was brown-red in color with a yellowish-green lustre, and which dissolved in alkalies with a magnificent blue color. To this substance he gave the name Gallein. A short time afterward he observed that this reaction was entirely general, and that whenever a phenol of any atomicity was heated in this way in presence of a dibasic organic acid, a coloring matter was the result. The body thus obtained gave rise to two derivatives; one of which is its anhydride, and the other its reduction product. For the coloring matter itself Baeyer proposes the termination *ein;* and for its reduction product, which is colorless, *in.* Thus with phthalic acid and phenol, for example, there is a phthalin and a phthalein of phenol. Among the various phenols which were thus treated with phthalic oxide was resorcin, one of the three diatomic phenols. Of course the products were a phthalin and a phthalein of resorcin. The phthalein of resorcin was obtained in yellow flocks which dissolved in ammonia, giving a red solution, which had such a magnificent green fluorescence as to secure for it the separate name fluorescein. It would seem as if a coloring matter like this, prepared from substances exceedingly rare, and obtained only in minute quantities by long and tedious chemical processes, could never become an article of commerce. But early in the present year Hofmann had placed in his hand a new coloring matter, which had only a few months before come into practical use. This new coloring substance had the name Eosin, a name given in allusion to the beautiful red color of its aqueous solutions, recalling that of the morning dawn. Upon investigation, eosin turned out to be a derivative of the remarkable coloring matter which Baeyer had called fluorescin. It was the potassium salt of tetrabrominated fluorescin, or, what is the same thing, of the phthalein of dibrom-resorcin. It is prepared commercially at the Baden Aniline Works, by Caro. Baeyer proposes the following test for it: A portion of the coloring matter is agitated with water and sodium amalgam at a gentle heat. The solution is soon decolorized, the bro-

mine being removed and colorless fluorescin produced. If now water be added and a few drops of potassium permanganate solution, the fluorescin changes to fluorescein, and the liquid becomes quite green and almost opaque in reflected light.—35 *C*, VIII., *January*, 1875.

PEROXIDE OF HYDROGEN IN THE ATMOSPHERE.

Schöne has made a series of experiments in the vicinity of Moscow to determine the amount of hydrogen peroxide in the atmosphere. Between the 1st of July and the 1st of December, 1874, he examined for this purpose one hundred and thirty specimens of rain and twenty-nine specimens of snow. Of the whole number of specimens of rain, only four failed to respond to the test, though out of the twenty-nine specimens of snow twelve gave no reaction. Having established the fact, the author continued his investigations with reference to the following points: (1) Form of occurrence of hydrogen peroxide in the atmosphere—whether gaseous or dissolved in the fluid or solid rain or hail; (2) relation to other meteoric phenomena, to time of day, and to season of the year; (3) relation to the ozone of the atmosphere; (4) how produced in the air; (5) part played by it geologically and botanically; (6) action upon the animal economy when breathed; and (7) hygienic importance. For this purpose, all the rain, hail, snow, dew, and frost were collected and tested for hydrogen peroxide, the analyses being quantitative when possible. Further, at various times, especially in clear weather, artificial dew and frost were prepared and examined. Careful meteorological records were kept during the entire interval at the adjoining observatory. The ozone was determined with a Schönbein's ozonometer. The results show that the quantity of hydrogen peroxide in rain varies from 0.04 to 1 milligramme per liter; that the larger the drops the greater the amount; that the first rain after dry weather is poorer in peroxide than that which falls later; that the peroxide is greatest when the wind is south and southwest, that in the rain brought by the equatorial current being greater than that which falls in the rain produced by the conflict of this with the polar current, or brought by the latter current itself; that the relative quantity of peroxide in rain increases from the summer solstice

to the autumnal equinox, and then diminishes; that the quantity is not greater in rain which falls during a thunder shower; and that during the four months the absolute quantity of hydrogen peroxide contained in the 221 liters of rain which fell upon each square meter was only 62.9 milligrammes. In snow there was only 0.05 milligramme of peroxide to the liter, the amount diminishing toward the winter solstice. Natural dew and frost contain no peroxide, or at least less than one twenty-five millionth of this substance. In artificial dew and frost the amount of peroxide varied from 0.04 to 0.06 milligramme per liter, reaching on a bright moonlight night in summer 0.09 milligramme. The amount increased with the altitude of the sun. The daily maximum was reached between 12 and 4 o'clock P.M., and the annual maximum in the month of August. The amount is greater the higher the temperature, the clearer the sky, the higher the absolute and the lower the relative humidity of the air. The author concludes that the peroxide is contained in the air both free and in solution, to the extent as a maximum of 0.000000268 c. c. in a liter. He also believes that sunlight plays an important part in its production.—35 *C*, VII., 1693.

TARTRONIC ACID A GLYCERINE OXIDATION PRODUCT.

Hitherto tartronic acid has only been known as a product of the spontaneous decomposition of nitro-tartaric acid and as a reduction product of mesoxalic acid. Theoretical considerations led Professor Sadtler, of the University of Pennsylvania, to conceive that this acid might be formed by the oxidation of glycerine, and hence to search for its presence in the products of this reaction. For this purpose one part of glycerine was mixed with an equal weight of water, and to this was added about one and a quarter parts of fuming nitric acid. This latter was poured into the vessel through a long funnel tube, so as to form a layer upon the bottom. After about six days the evolution of gas had ceased, and the solution was evaporated at a gentle heat to a sirupy consistence, then diluted, and lead carbonate added in excess. The liquid filtered from the mixed lead oxalate and carbonate gave, upon evaporation, thick crusts of lead glycerate. These, redissolved in water, were freed from lead by hydrogen sulphide, the solution concentrated, neutralized by

calcium carbonate, filtered, and treated with an equal volume of alcohol. After twelve hours the greater part of the calcium salt had completely separated. At first the author supposed this to be calcium glycerate in a pure form; but by solution in warm water it left a residue, which only dissolved by long boiling. This residue, about a tenth part of the entire salt in amount, was filtered off, washed, and dried. It appeared as a white powder, non-crystalline. Upon analysis this powder gave numbers agreeing very closely with calcium tartronate. Conversion into the acid confirmed this supposition. Under the glass the acid crystallized in tables having the form of the tartronic acid from nitro-tartaric acid. This view was confirmed by the results of its elementary analysis.—35 *C*, VIII., 1456, *Nov.*, 1875.

ACTION OF WEAK ACIDS ON SALTS OF STRONGER ONES.

The importance in chemical dynamics of the question, What is the condition in which several substances exist when in solution? has been oftener recognized than experimentally investigated. Bergmann advanced long ago the theory that is now generally maintained, *i. e.*, that universally bodies combined according to the strength of their chemism. Berthollet, on the other hand, asserted that when different salts were dissolved together, as many bodies were formed as by the exchange of acids and bases were possible. Among the experiments made to settle the question, those of Bettendorff are perhaps the most satisfactory. By studying the action of light on certain solutions, he was led to decide for the view of Bergmann. Hübner and Wiesinger, not regarding these experiments of Bettendorff as sufficiently numerous or comprehensive, have made use of a different method for solving the problem by making the distinct proposition: Can a dissolved acid expel a stronger one from its salts in solution without any substance separating from the solution? For these experiments they used benzoic acid for the weaker and nitrobenzoic acid for the stronger acid. They are both monobasic, are easily obtained pure, are easily separated from each other and from their salts, and can be recognized with certainty. They differ only apparently in the strength of their chemism. In the qualitative experiments, barium nitrobenzoate and free benzoic acid were dissolved

in a large excess of water, the solution being heated to 80° Centigrade. After cooling to 14°–17°, the solution contained not only the substances originally dissolved, but also free nitrobenzoic acid and barium benzoate. The nitrobenzoic acid set free in the reaction, together with the benzoic acid also present, was dissolved by agitation with chloroform or benzene, in which the barium salt is insoluble. In the residue, after the solvent was distilled off, the presence of nitrobenzoic acid was proved by means of sodium. In a quantitative experiment, 1.6592 grammes of pure barium nitrobenzoate was mixed with the theoretical quantity 1.1815 grammes of pure benzoic acid, and dissolved in an excess of hot water. The nitrobenzoic acid obtained from the solution was 0.2341 grammes, being 19.81 per cent. of the whole quantity. Additional experiments seem to show that the quantity of the stronger acid set free depends on that of the weaker.—35 *C*, VIII., 466, *April*, 1875.

COPPER IN THE HUMAN BODY.

Not long since, in a case of suspected poisoning by a salt of copper, upon analysis a large percentage of metallic copper was found in the liver and kidneys. Subsequent research, however, proved that copper usually exists as a normal constituent of the animal body, the investigation having taken place upon fourteen human subjects from the French hospitals. Portions of these were first dried, then carbonized, and the ashes treated for copper, the amount of which varied in quantity from $\frac{7}{10}$ to $1\frac{1}{2}$ milligrammes. The same metal has even been found in the liver of the human fœtus.—13 *B*, *Feb.* 20, 1875, 186.

RELATIVE AMOUNTS OF POTASH AND SODA IN MILK AND OTHER FOOD, AND IN THE ENTIRE BODY.

In pursuing the investigation of the value of salt in nutrition, Bunge was led to determine the amount of the alkalies and of chlorine in the most important articles of food, especially in milk; and, in this connection, the amounts of the alkalies and of chlorine in the entire bodies of a number of animals was also ascertained. Besides analyses of human milk, and of that of herbivorous and carnivorous animals, analyses were also made of the entire bodies of a mouse,

four cats, two young dogs, two young rabbits, five rabbit embryos, and of a number of butterfly chrysalides, and the amount of soda and of potash in different articles of food was found. From the numbers thus obtained, and given in tabular form, interesting conclusions were drawn, in regard to the relation existing between the food and the composition of the body, as regards the amount of the alkalies and chlorine present. In vegetable food the excess of potash over soda, compared by equivalents, is much greater than in human milk, or those in that of herbivorous animals; so that, if the proportions of potash and soda in milk are to be considered as the most favorable to nutrition, the addition of salt to all the more important vegetable articles of food is indicated. The amount of soda in the organism varies within as wide limits in the animal kingdom as in the vegetable, and the amount of soda, potash, and chlorine in milk is not constant, but varies with the food and other conditions. The young of the carnivorous animals receive in their milk potash and soda, and generally all the fixed ingredients, in almost the same proportions required for their growth; and while in the bodies of the young of herbivorous animals the relative amounts of soda and potash are found to differ from those of the carnivorous animals, the relative amounts of these substances secreted in the milk by which they are nourished conform to this difference. Prolonged feeding, however, upon substances rich in potash and poor in soda will increase the relative amount of the former in the milk.—19 *C*, *Jan.* 23, 1875, 35.

E. MINERALOGY AND GEOLOGY.

POT-HOLES, OR "GIANT KETTLES."

It is not always that geological investigations have as their object phenomena which are of general interest, and with which all are more or less familiar. This is certainly the case, however, with the study of the "giant kettles" in the neighborhood of Christiania, Norway, which has been lately carried on by Professor Kjerulf and some of his students. There is hardly a running stream in our country of any considerable size which does not give proof of the power of water and stones in motion in what are popularly called "pot-holes." An eddy in the stream where the current is strong sets a few pebbles in revolution. These commence a depression, into which larger stones fall, and the grinding is continued until a cavity has been produced perhaps several feet in depth, and almost perfectly round. These are often to be observed, not only in stream beds, but also in rocks on the sea-shore, where the rush of the tide must supply the motive force.

The famous "giant kettles" of Norway are simply "pot-holes" on a larger scale, and produced in former times under somewhat different conditions than we have at present. The superstition of the people represents them as having been made by giants. In some places, where the form is oblong and irregular, fancy has seen in them the footprints of these monsters, while in one place, where the road goes directly through a very large kettle, the saying is that there St. Olaf turned his horse around. On the west coast of Norway another name is used, and they are spoken of as giants' chairs.

The description of one of these kettles examined by Professor Kjerulf will give some idea as to their size and general character. At the surface it had a diameter of about eight feet, being slightly elliptical in form. It widened considerably on the descent, and then contracted again at the bottom. It is interesting to note that the walls were distinctly worked out in a spiral, which could be traced from top to

bottom. In the case of some other kettles examined, the spiral was so perfect that the cavity could be compared to the impression of a gigantic snail.

The total depth of the kettle in question from the highest point of the margin was forty-four feet, the axis inclining somewhat toward the west. It was filled, as is always the case, with gravel and broken rock, though toward the bottom numerous so-called grinding-stones were found, some of them 300 pounds in weight, and all smooth and elliptical in shape. It was through their revolution that the excavation had been made. It required three men, working for fifty days, to clear this giant kettle of its contents, and the whole amount taken out was estimated at 2350 cubic feet, some of the stones being so large that they had to be mined before they could be hoisted out.

The kettles, in general, present much the same features as the one which has been just described, though there is a great variation in ratio of width to depth, many of them being shallow, larger at the top than at the bottom, and very properly are called kettles, while others, as the one alluded to, are deep, and could better be called wells. It is to be observed that they are by no means necessarily found in present river channels. They are most common in the neighborhood of the great fiords, though they have been observed too at a height of 1200 feet above the sea. In regard to their origin, the best authorities refer it to the time when the land was covered by enormous glaciers, such as now exist in the upper part of Greenland. The melting of the ice on the surface of glaciers gives rise to considerable rivers, and as these find some crevice in the ice, they descend with violence, and it is conceivable that such a stream striking the bed rock below might be the means, with the masses of rock they would put in motion, of producing the enormous cavities which are now observed. This theory, as carried out by its supporters, meets with some difficulties, but seems to be the best which has been proposed.

PROBABLE AGE OF THE CRYSTALLINE ROCKS OF THE SOUTHERN APPALACHIANS.

Professor Bradley, of Knoxville, Tennessee, has recently published the results of his geological labors among the

Southern Appalachians, which throw much light upon the probable age of the crystalline rocks of that region. It has long been the tendency of geologists to regard the metamorphic crystalline rocks of the Atlantic coast as certainly pre-Silurian. This has, however, been called in question by the observations of Professor Dana, which go to prove that the limestones and accompanying schists and quartzites of Western New England are *all* Silurian, and not Huronian nor Laurentian. Professor Bradley now claims the same for the region he has investigated, that is, the western portion of North Carolina, the eastern part of Tennessee, and much of Georgia and Alabama. The evidence upon which the conclusion is based is stratigraphical, and must be studied in detail to be fully understood. The time at which the uplift and metamorphism of this region took place is considered by Professor Bradley to have been post-carboniferous, and it is probably referable to the close of the paleozoic.

DISCOVERY OF A BED OF NICKEL IN NORWAY.

It is announced that a very rich bed of nickel has been recently discovered in the forest of Glörud, in Norway. The ore proves to contain 3.59 per cent. of pure metal, an exceptionally large proportion.—13 *A*, *September* 4, 1874, 263.

MAGNETIC SAND IN LABRADOR.

It is stated that, within a few years past, large quantities of magnetic iron ore, in sand, have been discovered on the north coast of Labrador, and that Mr. Lamothe, of Montreal, has more recently been engaged in bringing this to public notice. A company was formed, and forges were built at Moisie, which are now in operation, since when other localities have been determined along the north shore, especially at Matashquan, Kegashka, St. John River, and St. Marguerite. Several attempts have been made to purify this sand in a rapid and economical manner, and to make steel from the ore by a direct process, and these problems have now been solved by Professor Larne and Mr. Kizer, of Montreal. An establishment has also been erected at Block Point, between St. John River and Mingan, for the preparation of the sand and its exportation to Swansea. It contains, in the rough state, 30 per cent. of the magnetic iron, and when prepared

99 per cent. It is expected that thirty tons per day will be furnished at this place. Works for the manufacture of steel from this sand have been established at Quebec, and at Matashquan others are being put up. The ore is said to excel that of New Zealand in richness, and it is probable that before long it will occupy a permanent place in the iron industry.

INTERESTING PHENOMENA OBSERVED IN STONE QUARRIES.

Professor W. H. Niles, of the Boston Institute of Technology, communicates the results of further observations of the peculiar phenomena observed at the stone quarries at Monson, Massachusetts. Similar phenomena have been recorded once before by Professor Johnston, of Middletown, Connecticut, in relation to the sandstone quarries at Portland, in that state. Both these gentlemen concur in the same conclusion, namely, that the strata of sandstone at Portland and the strata of gneiss at Monson are not at the present time perfectly at ease in their ancient beds, but that, in some way, they have received a disposition to change their position slightly; that, in fact, they exist there in a state of compression, the force with which they tend to expand being so great that it has been known to break apart beds of the thickness of three, four, and five feet, for a distance of 100 feet or more; while in another case one end of a long prismoid of gneiss, being solidly attached to the undisturbed rock, the other end, by its expansion, pushed upward about 10,000 tons of rock. The expansions at Monson take place only in a northerly and southerly direction. The cracks and rents are generally formed slowly, but sometimes suddenly, attended by a loud report similar to that of a slight shock of earthquake, and sometimes by the throwing of stones of considerable size to the distance of several feet.—*Proc. Am. Assoc.*, I., 1873, 156.

CHANGES OF LEVEL ON THE COAST OF MAINE.

For many years there have been reports of changes in the depth of water on the rocks and shoals on the coast of Maine. From a report on this subject to the Superintendent of the Coast Survey, by Professor Shaler, the following facts have been gathered:

The natural indications of changes of level are the remains

of marine animals found above the level of high-tide mark; the presence of extensive stratified deposits, at points where fresh-water lakes could have had nothing to do with their formation; and the existence of a characteristic topography not explicable on any other supposition than that of marine action. In his investigation of the coast of Maine, Professor Shaler has not been able to rely to any great extent upon the first of these three natural indications; the evidence afforded by the extensive stratified deposits has been to him the most important, both in its nature and its quantity. Taking the masses of stratified drift as the only acceptable and abundant proof of depression, he considers that we must look at the question of the origin of these bodies of drift and the possibility of their being formed by other agents than those which are at work in the sea. Some slight amount of stratification seems not inconsistent with the theory of the action of water in the formation of extensive sheets of drift; but when the stratified drift is distributed in extensive sheets along the shore, all doubt of marine action may be fairly put away.

The neighborhood of Boston, like the whole country southward to New York, is characterized by having a vast accumulation of drift materials disposed in four distinct formations, each indicating a separate stage of the glacier period; namely, first, massive drift in patches, which are the fragments of a great body of drift of great thickness left by the old glacier ice-sheets. This drift is quite without traces of stratification, and a large part of its pebbles are scarred by glacier scratches. Second, bodies of glacier material rudely distributed by water, the glacier scratches generally worn away from the surface of the pebbles, the whole indicating one or more of the processes by which the re-elevation of the country was effected after the passage of the glacier ice. Third, a secondary glacier series, indicating the recurrence of local depressions after the partial re-elevation of the country. These secondary glaciers in the neighborhood of Boston occupy only the larger stream-beds. Fourth, the rearranged beds lying within a few feet of the present level, which indicate a long-continued rest of the sea, at or near its present place. At this level the life-bearing bodies of drift come again into prominence. Fifth, the extensive mud-beds and

marshes always colored by the remains of animals and plants. As we go southward from Boston we gradually pass to an area of increased table drift of indistinct stratification, and corresponding to the first of the preceding five geological epochs. At Portland we have decided evidence to show that the depression of the glacier period was 150 feet, or double that of Boston. East of Portland, and covering the country as far as New Brunswick, we have proof of the existence of a set of local glaciers covering the shore, and continuing until the final re-elevation of the land to near its present level. In some remarks upon the origin of the glacier epoch, Professor Shaler has recourse to the theory that our sun is a variable star.—*Mem. Bost. Nat. Hist. Soc.*, II., 1874, 321.

NEW MINING REGION IN NEW MEXICO AND ARIZONA.

The *Engineering and Mining Journal* quotes from a New Mexican paper an account of a very rich and extensive copper region lately opened in New Mexico and Arizona, in the vicinity of the White Mountain Indian Reservation, which from its importance seems likely to eclipse all other mining portions of the Southwest. This results partly from the great amount of ore of unsurpassed richness, and partly from the simple method by which the metal may be reduced. In the region referred to one solid wall of copper ore has been exposed for a distance of 250 feet, and from 10 to 15 feet in height, and of enormous width, yielding 70 per cent. of pure copper. Still larger veins have been found in the neighborhood.—17 *D*, *December* 12, 1874, 371.

PETROLEUM SPRINGS IN NORTH GERMANY.

Petroleum springs have lately been discovered in considerable quantity on the Lüneburg Heaths, in Northern Germany. The oil, in clearness, purity, and specific weight, is said to be identical with the American rock-oils, and it is almost without smell of any kind.—13 *A*, *November* 14, 1874, 532.

COAL-MINES IN RUSSIA.

Extensive coal-mines have been discovered in the Jekaterinoslaw district, in the lands of the Don Cossacks of Russia. These lie at a depth of about 200 feet, and the yield is so abundant that many thousands of tons have been shipped

from the port of Taganrog. It is thought that this coal will answer an important purpose in connection with the Suez steam navigation, and in all probability drive out of use in that region the English coal which is now universally employed.—13 *A*, *November* 14, 1874, 532.

COAL-FIELD NEAR DRANISTA.

A coal-field has recently been explored by a party of English engineers near Dranista, which is about fifty miles southwest of the town of Salonica, and is inclosed by a range of mountains of crescent shape, commencing on the south at Mount Olympus, and terminating on the north at the bay of Kitros, in the Gulf of Salonica. An aggregate thickness of about eight feet of coal has been found, extending over an area of 2000 acres, although it is thought probable that the coal-field is of much greater extent, and that the basin contains 255,000,000 tons of coal of good quality.—13 *A*, *November* 14, 1874, 532.

GEOLOGY OF COSTA RICA.

Professor Gabb, in a communication to the *American Journal of Science*, gives some account of the geology of a portion of Costa Rica, which he has been engaged in exploring for some time past, and takes occasion to point out the fact that the highest peak in the country is not the Irazu, as has been generally supposed, but the Pico-Blanco, which he estimates at about 10,200 feet. From its summit large extents of both the Atlantic and Pacific are readily visible.

Geologically the Pico-Blanco is not a volcano, but a culminating point of granite intrusion from below miocene rocks. There is, however, a large mass of true volcanic rock forming the apex, which, nevertheless, is only a dike laid bare by denudation, and does not extend 300 feet below the summit.—4 *D*, *November*, 1874, 389.

FALLING OF ATMOSPHERIC DUST IN NORWAY, MARCH 29 AND 30, 1875.

Professor Daubrée communicates to the Academy of Science, in Paris, notes upon certain atmospheric dust which fell in Sweden and Norway in the nights of the 29th and 30th of March, 1875. This was found scattered over the snow,

and was obtained by melting and evaporating the latter. The first impression on examining the dust was that it had a meteoric origin, representing a condition not unfrequently observed in the atmosphere. Careful investigation, however, finally induced the belief that this was a volcanic phenomenon, the dust being possibly derived from some eruption in Iceland. Professor Daubrée, in remarking upon the great distance to which volcanic and other ashes may be transported, states that a certain dry fog which covered nearly the whole of Europe, in 1783, was due to a volcanic eruption in Iceland; and that ashes from the Chicago fire fell on the Azores on the fourth day after that catastrophe. These gave out an empyreumatic odor, which induced the suggestion, at the time, that some great forest on the American continent must be on fire.—6 *B*, *April* 19, 1875, 995.

COAL IN THE STRAIT OF MAGELLAN.

An important discovery, if correctly represented, has lately been made in the opening of a rich coal-mine in the southern part of Patagonia, near Brunswick Island, in the Strait of Magellan, in the locality known as Captain Corey's Ranch, near the Chilian colony of Punta Arenas, in latitude 53° 9′ S. and longitude 73° 13′ W. The property referred to has been granted by the Chilian government to three French explorers, Messrs. Bouquet, Derue, and Suzainecourt. There are three distinct beds of the coal, of which one is about 300 feet above the level of the sea, of a minimum thickness of about 6½ feet. The second is from five to six feet in thickness, and is about 170 feet above the first. The third is about 130 feet above the second, with a thickness of 16 feet, divided into three nearly square layers, and separated by thin strata of slate. In view of the large number of steam-vessels annually traversing the Strait of Magellan, an unlimited supply of good coal in that locality is a matter of very great importance.—1 *B*, *October* 11, 1874, 17.

TIN IN NEW SOUTH WALES.

The tin-bearing country in New South Wales, of which so much was said a few years ago, still continues to be noteworthy for the extent and value of the take of this valuable metal. The amount raised in Inversall, which is but a small

portion of the region where the metal occurs, amounts to about 800 tons during the past year. The principal mines are on Coke's Creek, Middle Creek, and MacIntyre River. The rocks are granite, greenstone trap, carboniferous beds, miocene, pliocene, quaternary, the latter including drift deposits. The stream tin is found in the drift as well as in the miocene, and valuable veins of tin ore occur in granite which is believed to be of upper carboniferous age.—4 *D*, *November*, 1874, 403.

GOLD IN EASTERN SIBERIA.

Gold was obtained during the year 1874, in large quantities, from the region of the Upper Amoor of Eastern Siberia. —13 *A*, *November* 14, 1874, 532.

ORIGIN OF THE RED CHALK AND THE RED CLAY.

Professor Church, in a recent number of the *Chemical News*, communicates an article upon the red chalk and the red clay, in which he points out a striking relationship between these substances as existing in England, and the gatherings in the recent deep-sea explorations from the bottom of the sea. We have already referred to Professor Thomson's explanation of the origin of the latter; and Professor Church gives us good reason to suspect a close parallelism in point of origin between the two, the chemical composition as well as physical character of the chalk agreeing very closely with those of the red residue obtained by Mr. Buchanan from the globigerina ooze, and those of the red smooth clay brought up from the deeper part of the sea bottom.

There are differences between the two, to which Professor Church adverts, but these, in his opinion, may be caused by subsequent conditions which we are at present unable to appreciate. Both substances appear to be entitled to the designation of a silicate of red oxide of iron and alumina, and to have been derived in all probability by the removal, in different degrees, of the calcareous matter from the original material. The question of the occurrence and origin of glauconite, a variable silicate of grayish green color, is also discussed; and the similarity caused by its presence between the cretaceous and greensand strata in Europe and America, to the recent greensands of the Australian seas and of the

Agulhas current, are considered. The precise problem of the forms of the recent greensands, or rather of glauconite matter, at given depths in the red clay, is not yet satisfactorily answered.—1 *A*, *May* 7, 199.

ZONOCHLORITE AND CHLORASTROLITE.

Some time ago, under the name of zonochlorite, Professor Foote described a mineral species found at Neepigon Bay, Lake Superior. This species has recently been re-examined by Mr. George W. Hawes, who placed thin sections of it under the microscope. It consists of green earthy particles disseminated in a white mineral, and hence is evidently not a true species, but a mixture. Analysis shows it to be essentially nothing but a very impure variety of prehnite. The chlorastrolite from Isle Royale has also been reinvestigated by Mr. Hawes, both chemically and microscopically. This, too, appears to be but a mixture similar to zonochlorite. Its specific gravity is somewhat higher than that of pure prehnite, a fact which Mr. Hawes thinks may be due to a slight admixture of epidote.

WAPPLERITE.

This new species is found at Joachimsthal, in crystalline crusts resembling hyalite, in small botryoidal aggregates, and in crude vitreous masses. It is a hydrated calcium arseniate, containing eight molecules of water. Three of these molecules are driven off by a temperature of 100° Centigrade, when, like pharmacolite, it is converted into haidingerite. Frenzel is the discoverer.

CLARITE.

Under this name Roemer describes a dimorphous modification of enargite, found in the Clara mine, near Schapbach, in the Baden Black Forest. Chemically it is enargite, but varies from the latter in color, density, and crystalline form. Clarite is dark, lead gray, and monoclinic; enargite is iron black, and rhombic.

CHALCOPHANITE.

Under the above name Dr. Gideon E. Moore describes a new mineral from the zinc mines at Stirling Hill, Ogdens-

burg, N. J. It occurs in druses, lining the walls and cavities, and also in foliated aggregates of minute crystals. The color is bluish black, lustre metallic, specific gravity 3.907. Its composition is very remarkable, since it contains zinc oxide, manganese monoxide and dioxide, and water. It is therefore a hydrate of manganese and zinc, containing the former metal in two states of oxidation. By heating it changes color, and becomes of a tint varying from yellowish bronze to copper red. The new mineral is apparently a product of the decomposition of franklinite and some of its associated species.

THE MASSACHUSETTS SILVER-LEAD MINES.

The following facts concerning the development of silver-mining in Massachusetts are given on the authority of Mr. C. W. Kempton, mining engineer, of Newburyport, Massachusetts. The mining region, according to the statement of this gentleman, extends from Gloucester, Massachusetts, on the south, to Portsmouth, New Hampshire, on the north, and from the Atlantic, on the east, to a line drawn north and south through "Great Pond," North Andover, Massachusetts, on the west. Within this region is located the first discovered, and thus far the most prominent lode — the "Chipman" — situated in the northerly part of Newburyport, and which has been traced for a distance of three miles. The dip is nearly vertical, and slightly to the north. The ore is chiefly galena, carrying from 50 to 150 ozs. of silver to the ton, with some gold, blende, copper, and pyrites. There is native silver in the quartz, and stephanite has been found. The Chipman and Boynton shafts are on this lode; the last named is down, at the time of this writing, some 100 feet. About $20,000 worth of galena ore was taken out of the Chipman at the start, in sinking the first 75 feet of the shaft. The average thickness of vein-rock on the Chipman lode is about 60 feet. The lode lies between granite on the north and slate on the south. There are not less than eleven parallel veins in this section of the mining district, on several of which mining operations have been commenced, showing well in the majority of cases.

Our informant likewise notices a second variety of ore, viz., the veins carrying tetrahedrite, which often runs ex-

ceedingly rich in silver. Of these, the "Bartlett" is spoken of as the most prominent, having an outcrop of vein-rock (limestone) something near to 100 feet in thickness. This vein is described as yielding an abundance of ore, carrying from 200 to 1100 ozs. of silver per ton, and 30 per cent. of copper. Several such gray copper veins are known, and lie in contact with porphyry. A third class of veins lies between the galena veins on the north and the porphyry on the south. They carry both galena and gray copper, but have not thus far been sufficiently investigated to enable an opinion to be formed as to their value.

LAKE AREA OF THE EOCENE AGE IN NEW MEXICO.

One of the most important results of the geological survey of New Mexico, conducted by Lieutenant G. M. Wheeler, United States Engineers, during the season of 1874, is the discovery by Professor Cope of an extensive lake deposit of the eocene age in the western and northern parts of that territory. The deposits cover at least three thousand square miles, and are three thousand feet in thickness, being worn into remarkable bad-land deserts in some localities. This is only the second lake area of this age discovered in the West, the survey under Clarence King having discovered the longest known, viz., that of Wyoming, some years ago. Professor Cope discovered the remains of about one hundred species of vertebrata, mostly mammals, in the New Mexican formations, many of them of peculiar character, and to a great extent different from those of the Wyoming eocene. Carnivora of an antiquated pattern were abundant, and hoofed animals related to the tapir. Eight species of an almost unknown order—the Toxodontia, which is related to rodents and elephants—were also found.

CHAMPLAIN DEPOSITS OF SOUTHERN NEW ENGLAND.

Professor Dana, in continuation of his essay upon the geology of the vicinity of Hartford, Connecticut, published in the *Journal of Science*, remarks that there are three prominent facts indicated by the Champlain deposits of Southern New England. First, the occurrence of a vast flood during the closing part of the melting of the glacier, in which other parts of New England participated; second, the absence of

marine life from Long Island Sound through the glacial period and the early part of the Champlain period; third, a participation in the subsidence which affected the regions farther north. For all these he presents numerous data in evidence. He finds that while the glacial ice of the White Mountains was not less than 5800 feet, and perhaps even greater, in Southwestern Massachusetts it only extended to the height of about 2600 feet above the sea. Following out the more conclusive evidence, Professor Dana estimates the height, at New Haven, at from 1500 to 2000 feet. This, in his opinion, furnishes at the melting time material for swelling certain waters at least to universal floods. The sinking of the land that took place after the ice had reached its height, placing the site of Montreal five hundred feet below the sea-level, making Lake Champlain an arm of the great St. Lawrence Gulf, and other high latitude lands much below the present level, presents, he thinks, a sufficient reason for the change of climate which began the thinning of the glacier, and finally hurried on its dissolution.—4 *D*, *September*, p. 169.

GAS WELLS OF PENNSYLVANIA.

The opinion is daily growing more decided among those who are well informed that the gases which are constantly escaping from innumerable wells throughout the oil region of Pennsylvania and adjacent states, represent a value but little, if at all, inferior to the oil itself. The next step after the realization of this fact is its utilization; and, from occasional paragraphs that from time to time appear, there is reason to believe that the industrial employment of this material, of which inestimable volumes have for years been permitted to pass uselessly into the air, will soon become very general. In a few instances the wells have been tubed, and their product utilized with most satisfactory results. We add herewith the following from the *National Oil Journal*, which indicates that some progress is being made in this important field. The *Journal* remarks that the yield of the few gas wells that have been tubed shows that the quantity of the product is enormous beyond computation. A gas well near Sarnersville, in the Butler oil region, flows with a pressure of three hundred pounds to the square inch, and

is roughly estimated to yield a million cubic feet of gas every twenty-four hours; and this is only one of many large gas wells, and almost numberless small ones; for it must be remembered that every well which produces oil yields gas also. A survey has just been completed for a line of pipe from Sarnersville to Pittsburgh, a distance of about seventeen miles. It is proposed to lay a six-inch pipe between the points named, and to supply the gas to the manufacturing establishments in Pittsburgh as a substitute for coal.

MELANOSIDERITE, A NEW MINERAL.

Professor Cooke, of Cambridge, has described a new mineral under the name of Melanosiderite. It is compact and amorphous, very brittle, and with a conchoidal fracture. Its lustre is vitreous, color black, and streak brownish-red. In hardness it lies between fluor-spar and apatite, and its specific gravity is 3.39. An analysis shows it to consist essentially of silica, iron, and water; and Professor Cooke regards it as a very basic silicate of iron, most closely allied to Hisingerite. It comes very near to the common sesquihydrates of iron, but its low specific gravity is regarded as showing a marked distinction from them. It was found in Chester County, Pa.

Professor Cooke has also continued his investigations of the vermiculites, and has described two new varieties, one from Delaware County, Pa., the other from Pelham, Mass. His labors on this group of minerals have led him to the conclusion that they are all unisilicates, and combine with water in several definite proportions, but that the only essential difference between them is in the ratio between the sesquioxide and protoxide bases.

F. GEOGRAPHY.

REPORT OF A RECONNAISSANCE OF NORTHWESTERN WYOMING.

The report of a reconnaissance of Northwestern Wyoming, made in the summer of 1873 by Captain William A. Jones, of the United States Engineers, has just been published by Congress in a volume of 210 pages, with a large number of plates. It embraces a descriptive journal of the route, which started at Fort Bridger, via the Shoshone Agency, and the valley of the Big Horn to Yellowstone Lake and the Three Tetons, and thence returned to Camp Brown.

The second chapter is specially devoted to the geography of the route, and especially that of the region about the Yellowstone Lake, previously reported upon by Dr. Hayden. There are also chapters on the meteorology of the region, an astronomical report, and a very detailed geological report by Professor Theodore B. Comstock. Dr. Heizmann, of the army, furnishes an account of the mineral and thermal waters. The botany is described by Dr. C. C. Parry, and the entomology by Mr. J. D. Putnam.

The most important result obtained by the expedition is the determination of a new and short route to the Yellowstone National Park, this being the result of the discovery of the Togwotee Pass, which permits a direct line to the region in question. This pass is at the head of Wind River, a little southeast from Yellowstone Lake, and constitutes a perfectly practicable passage to the Yellowstone Valley, via Wind River Valley. The other passes through the Sierra Shoshone are very difficult of transit.

Togwotee Pass is in latitude 43° 46′ 29″, longitude 110° 1′, and has an altitude of 9621 feet above the sea. Notwithstanding this altitude, the slopes approaching the summit are so long and regular that a railroad can be built over it at a reasonable cost. The route will be available at once for the construction of a wagon road.

The present route of travel to Montana leaves the Central Pacific Railroad at Corinne, and runs in a northerly direction through Idaho to Montana, crossing the Bannock Mountains

on the divide between the Snake and the Missouri rivers. The distance from Corinne to Fort Ellis is 403 miles. The proposed road leaves the Union Pacific Railroad at Point of Rocks, Wyoming, and runs about north into the Wind River Valley, thence up that valley to its head, and through Togwotee Pass northerly to Yellowstone Lake, and through the Yellowstone National Park to Fort Ellis. This route passes all the principal curiosities of the National Park except the geysers, which can easily be reached by a short side road. By it the distance from Point of Rocks to Yellowstone Lake is 289 miles, and to Fort Ellis 437 miles.

The proposed route saves 250 miles of distance by railroad, 482 miles in reaching Yellowstone Lake, and 216 in reaching the principal cities in Montana. Besides this, it runs directly through the Yellowstone National Park, which at present is very inaccessible, and it will eventually be the shortest railroad line to Montana. It opens up a very large tract of low-lying timber land (about two millions of acres), and will prepare the way for the settlement of the Wind River Valley, the Teton Basin, and the valley of the Upper Yellowstone, and will finally throw open the Yellowstone National Park to the wonder-seekers of the world.

ON THE PROPER ARRANGEMENT OF GEODETIC TRIANGULATIONS.

In a recent Appendix to the Report of the Coast Survey, Mr. Schott says that whatever may be the design of any geodetic operation, it must be based upon a triangulation; and the greater or less complexity of the net-work of triangles will depend chiefly on the hypsometric features of the country. The adaptation of the triangulation to these various conditions, paying proper attention to accuracy, economy, and rapidity, requires especial consideration in each case. If the question is how to arrange the net-work of triangles in the most effective manner, we shall, in general, have to decide between one of four arrangements. A series may be formed of a single string or triangles, a double string or lozenges, a triple string or hexagons, and a quadruple string or quadrilaterals; or it may be composed of a more complicated combination. The single string is to be adopted when economy and rapidity are the first requisites; the hexagonal

system when a large area is to be covered; a series of quadrilaterals is the system possessing the greatest strength or accuracy. The relative values of these three systems may be determined by the consideration that the first, or triangular, requires the least number of stations; the third, or quadrilateral, necessitates the shortest lines of sight, and therefore the least obstruction by fog, haze, woods, etc. Among auxiliary methods which are needed for short distances where ordinary triangulation can not be applied, if we do not resort to actual measurements of long lines with rods or wires or rolling-wheels, we adopt that of Struve, which consists in measuring a number of small base-lines at right angles to the main course of the triangulation, so as to have one within each of a series of elongated quadrilaterals.—*Appendix* XV., *Coast Survey Report*, 1871.

THE MEAN HEIGHT OF EUROPE ABOVE THE SEA LEVEL.

The mean height of Europe above the sea level has been recently determined by Leipoldt, who calculates that it is about equal to 297 meters, which is 92 meters higher than the calculation of Humboldt. The mean height of Great Britain is 218 meters, and of Switzerland 1300.

GEODESY IN SWITZERLAND.

From the report of the Natural History Society of Switzerland we gather that the publication of the three sections of the primary triangulation work is now nearly completed. During the past year experiments with Bessel's reversion pendulum have been carried out by Plantamour, and exact levelings made, in order to connect together the principal stations. These latter have been investigated by Redard, who has found an error in altitude of one meter in the earlier portion of the work, between Locarno and Domodossola, by the rectification of which there seems now reasonable certainty that the entire Alpine polygon will exhibit no sensible error.—*Ver. Schweiz. Natur. Gesell.*, 1874, 113.

TRIGONOMETRICAL SURVEY OF INDIA.

According to the annual report of the Indian Trigonometrical Survey, seventy principal triangles, embracing an area of 7200 square miles, and extending over a linear distance

of 300 miles, have been measured. Of the topographical survey 3700 square miles have been executed. The southern section of the great Indian arc of the meridian has been completely revised, and Colonel Walker expresses his opinion that no portion of the principal triangulation remains which will ever be required to be revised, the last of the weak portions having been made strong and comparable with the best modern triangulation. In the course of the accurate work, determinations have been made of the rate of progress of certain sand hills near Cape Comorin. These travel progressively in a direction from west-northwest to east-southeast, which is that of the prevailing winds in this locality. They move at the rate of about seventeen yards per annum. Tidal observations are being made in the gulf of Kutch which promise to lead to valuable results. Very great difficulties were found in selecting suitable stations for fixing the tide-gauges—difficulties that were overcome only by sinking wells on the shore connected with the sea by open pipes, and in which wells the tide-gauges were set up.

THE HARBOR OF NEW YORK.

One of the most important recent contributions to the Coast Survey has been the renewed investigation of all the phenomena peculiar to New York Harbor, under the special direction of Professor Henry Mitchell. The physical survey of this harbor and its approaches require to be frequently renewed, in order to keep track of the numerous changes continually occurring both from natural and artificial causes. In the recent report of Professor Mitchell to the Superintendent of the Coast Survey, made in response to a resolution of the New York Chamber of Commerce, it is shown that the Jersey Flats no longer receive the deposits formerly carried by currents upon its interior space. In consequence, the deposits have accumulated to such an extent upon the fore slope of the bank that the flats are rapidly growing out into the main channel. If these flats are to be occupied by buildings, provision should be made specially for keeping a bold frontage. In the vicinity of Middle Ground Shoal and of Gowanus a similar movement outward seems to be taking place from a similar cause. The importance of the East River to the preservation of the entrance to New York Har-

bor is shown from the fact that the whole movement of water which flows into New York Harbor in the course of each tide through the East River is sufficient of itself to raise the water of the harbor by one and one-tenth feet. The turn of the tide in the East River occurs two hours after the ebb begins in the harbor, and during these two hours the flow is toward the East River instead of from it. As the result of some calculations, it is shown that the whole of the flow through the Narrows corresponds to five and three-tenth feet in elevation of the surface of the harbor, and this is the amount which would run through if the East River were to be cut off. An additional nine tenths of a foot, however, is to be added as due to that which comes from the East River itself, giving a total of six and two-tenth feet, representing the flow through the Narrows and over the bar. If, therefore, the East River were cut off, the corresponding decrease in the flow of water and decrease in the scouring of the bar would involve a reduction of the depth of water upon the bar of about three and a half feet. Therefore the loss of this river, or any obstruction to its flow or reduction of its capacity, become injurious to the harbor.—*Rept. U. S. Coast Survey*, 1871, 94.

THE DIFFERENCE OF LEVEL BETWEEN RARITAN BAY AND THE DELAWARE RIVER.

A line of leveling, seventy-seven miles long, has recently been extended by the Coast Survey from mean tide on Raritan Bay to mean tide at Gloucester City, on the Delaware River. Tides were observed at each station for the purpose of determining the true level of mean tide, which reference planes were fixed by means of permanent bench-marks established in the vicinity. These two bench-marks were made the termini of the line of levels. Every precaution, even to the extent of an entire re-leveling in an opposite direction, was taken for the purpose of avoiding all sources of error. The result has shown that the mean tide at Gloucester City is three feet five inches above the mean tide at Raritan Bay, which latter may be supposed to be the same as that of the ocean. In connection with this accurate leveling a series of barometric observations was made for the determination of the altitudes of neighboring geodetic stations, of which the

highest, that at Yard Station, is 480 feet above the ocean.—*Rept. U. S. Coast Survey*, 1871, 175.

NEW ROUTE BETWEEN AUSTRALIA AND CHINA.

Captain Moresby has brought to the notice of the Royal Geographical Society a new route between Australia and China, which lies to the west instead of the east of the Louisiade Archipelago, and is shorter than the present line of communication by three hundred miles.—13 *A*, *March* 6, 1875, 243.

PROGRESS OF BAROMETRIC HYPSOMETRY.

That the investigations of Ruhlmann into the sources of error in the determination of altitudes by means of the barometer has been the beginning of a new epoch in barometric hypsometry is evident from the applause with which his work has been received, and the several attempts that have been made by various meteorologists to carry out the methods of observation recommended by him.

In this connection we notice the publication, by Mr. Schott and Mr. George Davidson, of a short comparative study of the methods of determining heights by means of leveling, of vertical angles, and of barometric measures. This investigation appears to have been begun in 1860, when the observations were first made at two stations about fifty miles northwest of San Francisco; the field work was only completed in 1872, and consisted of hourly observations from early morning until sunset, with meteorological and geodesic instruments. The observations have been carefully discussed by Mr. Schott, and he has arrived at the remarkable result that between these upper and lower stations, and during the period over which the observations extend, the temperature of the intervening stratum of air was nearly constant throughout the entire day. There seems, in fact, no trace of a daily variation, as though the rays of the sun passed through the air without sensibly heating it. For this location, therefore, we must conclude that the daily variation of temperature shown by ordinary thermometric readings belongs mainly to the layer of air in contact with or in close proximity to the earth's surface. The computed altitude of the upper station above the lower one, as compared with the true altitude de-

duced from careful levelings, shows that for an altitude of 2000 feet, and on the average of seven days' observations, the upper station is computed to be about eleven meters (that is, about thirty-five feet) too high. What the individual discordances are from these mean results is not stated; but judging from the similar results given by Ruhlmann, we are safe in saying that differences of altitude of 2000 feet can not be determined by the barometer within a hundred feet, unless the true temperature of the air is computed by Plantamour's or Ruhlmann's method, and is used instead of the observed temperatures directly given by thermometers. —*App. No.* 11 *U. S. Coast Survey*, 1871.

DECREASE OF WATER IN EUROPEAN RIVERS IN THE PRESENT CENTURY.

A suggestive paper has lately been communicated by Mr. W. G. Wex to the Geographical Society of Vienna upon the decrease of water in rivers and sources. The author states that the results of his observations tend to show the constant decrease of the rivers of Germany and an increase of the seas. They indicate that the levels of the German rivers are now much lower than they were fifty years ago, the Elbe having decreased to the amount of seventeen inches, the Rhine twenty-four, the Oder seventeen, the Vistula twenty-six, and the Danube fifty-five. The reason assigned for this is the progressing devastation of forests, which causes a decrease in the atmospheric moisture they attract and convey to the soil, and thence to sources of streams.—12 *A, February* 18, 1875, 314.

PHYSICAL PECULIARITIES OF THE UPPER VOLGA.

According to Poljakow, who has been exploring the region of the Upper Volga, under the patronage of the Russian Geographical Society, the Scandinavian Finlandic glacier, which at one time covered the Government of Olonez and those adjacent to it, must have stretched far into the basin of the Volga and over the boundaries of the Waldai plateau; and a connection must undoubtedly have existed between the Arctic and Baltic seas by the unequal levels of the lakes formed by the melting of the glacier, the slight remains of which are seen in the existing lakes.

Judging from the fauna, Poljakow concludes that the present upper course of the Volga must have been joined to the middle and lower course at a recent period, and in a measure accidentally. In this respect the Sheksna is to be considered the natural upper part of the Volga, as containing the very same fishes as those of the river Bjelosero.—12 *A*, *June* 17, 1875, 134.

PHYSICAL CHARACTER OF RODRIGUEZ.

We owe our first reliable information of Rodriguez to the members of the British party visiting that island for the purpose of making preparations for the transit of Venus. This part of the expedition was warned at the Mauritius that they must take every thing they required for subsistence, as it would be impossible to get any thing at Rodriguez. On reaching the island they found the vegetation very rank, the trees, however, of no great size, rarely forming a thick forest, but scattered singly over the slopes of the island. The most common tree seemed to be the vacoa (*Pandanus*), of which there appeared to be four species. The undershrub is very dense and spinous, rendering walking through it exceedingly unpleasant. Neither ferns nor mosses appear to be very abundant, but lichens are pretty plentiful. The rocks are largely columnar and basaltic, showing that at some period the island was exposed to volcanic action. Landing on the island was difficult, owing to the extent of the coral reefs.—12 *A*, *October* 29, 1874, 529.

EXPERIENCES OF THE "BASILISK" IN NEW GUINEA.

The recent experiences of the British surveying ship, the *Basilisk*, under Captain Moresby, to which we have already referred, have added greatly to our knowledge of the character of New Guinea and its inhabitants. To the three races heretofore known upon the island—namely, the Papuans on the south, the Arfaks of the mountainous country on the north, and the Malays of the northwest—Captain Moresby has added a fourth by the discovery of another, probably a mixed race of Malays and Papuans, inhabiting the whole of the eastern peninsula of New Guinea in its northern and southern shores, from about 148° longitude to East Cape, which is in 150° 53′, and the adjacent archipelago.

This race, while distinctly Malayan, differs from the pure Malay in being smaller in stature, coarser in feature, thicker lipped, and having more frizzled hair. The race merges into pure Papuan in the neighborhood of Cape Possession. They bury their dead in the ground, and build small thatched huts over them. Their houses, like those of the Papuans, are built on piles, and communicate with the ground by means of a pole notched with steps. They cultivate the ground pretty successfully, using stone mattocks for turning up the soil. Cannibalism appears to be known among them, but prevails only to a slight degree. The men are but slightly tattooed, while the women are tattooed all over in graceful patterns. Unlike the Papuans, they possess the art of making pottery. They are better fishermen than the Papuans, having a greater variety of implements, as well as of canoes. Up to the time of the visit of the *Basilisk* they seemed to have had very little acquaintance with white men.—12 *A*, *April* 24, 1875, 431.

MR. FORREST'S EXPLORATION OF AUSTRALIA.

Mr. John Forrest has succeeded in crossing from the western coast of Australia through the very heart of the only extensive region in Australia hitherto unexplored. He and his companions traveled nearly 2000 miles, keeping close to the twenty-sixth parallel of latitude. They left Champion Bay April 1, and reached the telegraph line September 27. Much of the country passed over was of the poorest possible description, scantily supplied with water. This achievement of Mr. Forrest leaves only the direct and more southern route to Perth to be traversed to complete the data requisite for making known the general character of the West Australian continent.—12 *A*, X., *December* 3, 1874, 93.

TOPOGRAPHY OF MICHIGAN.

In a pamphlet entitled "Popular Sketches of the Topography, Climate, and Geology of Michigan," Professor Winchell gives a table of the exact areas of the Great Lakes, which, according to him, are as follows, expressed in thousands of square miles: Superior, 32; Michigan, 20; Huron, 20; Erie, 6; Ontario, 6. The total length of lake shore-line within the State of Michigan is 1620 miles. He says that he has attempted to collect all the important information obtained, in running lev-

els in railroad and canal surveys, and has obtained data for the heights of six thousand places, which give the levels of the surface of the state at every point along the lines of survey. The planes of reference have all been compared with each other with great care, and all elevations reduced to Chicago city datum, which is low water in Lake Michigan in 1847. Contour lines for every fifty feet of elevation above Lake Michigan have been drawn, and are represented upon the maps accompanying the pamphlet, which presents a good general picture of the surface configuration. These tortuous lines, which to the casual observer may seem to be of little interest or value, will be highly appreciated by every intelligent person, and especially by those engaged in engineering enterprises. From the map it appears that the lake shores are depressed, the surface swelling gently up toward the interior regions; the rise being one or two hundred feet within a few miles, and afterward much more gradual. A few bluffs and steep shores are presented between Saginaw Bay and Lake Huron; but in general the steepest grades are found in the eastern portions of the state. Along the border of Lake Michigan stretches a series of sand dunes, or piles of fine silicious sand, piled up by the easterly winds to a height of one or two hundred feet. Back of these dunes the surface is depressed, and frequently occupied by marshes and lagoons. The average elevation of the interior of Lower Michigan varies from four hundred to one thousand feet, with many marks of the erosions that in post-geological ages have pared down the original surface, and established the existing slopes of the land and even the bottom of the lake. Eighteen summits are enumerated by Professor Winchell. They are usually gently undulating plateaus, through which drainage valleys of moderate depth have been excavated. In the northern peninsula, owing to the want of accurate data, so minute a survey can not at present be entered into. The highest summit on the Marquette and Ontonagon is 1186 feet; while the hills north of Lake Michigama are 1215 feet above that lake; and other points near by reach 1250 feet. Beyond the Ontonagon River the greatest altitude of the Porcupine Mountains is quoted at 1380 feet. Especial attention is called to the fact that the longitudinal axes of the topographical and hydrographical

feature of the state lie in directions which are diagonals between the cardinal points of the compass, showing, as Winchell thinks, that these axes are the resultant of two forces: a glacial force acting from the northeast, and a stratigraphical acting along the lines of strike of the rocky formations. The effect of the lake's temperature has received very full attention at the hands of Professor Winchell, who seems to have been the first to give us an exact idea of the great extent of that influence. Fifty-five meteorological stations in Michigan, and an almost equal number of stations in the neighboring states, have been employed by him in tracing out and marking the tortuosities of the isothermals of the lower peninsula of Michigan. The important facts disclosed by his researches in this respect have already been published widely in many journals, both in this country and in Europe; and these disclosures are destined to take their place among the most interesting phenomena of climatological science. In reference to the rainfall, he infers from the data at hand that the year 1871 was a year of remarkable dryness throughout the state.

THE TRIGONOMETRICAL SURVEY OF INDIA.

From the general report of the operations of the great trigonometrical survey of India during 1873 and 1874, we gather, that of the principal triangulation, seventy triangles, covering 7200 square miles, have been measured. The secondary triangulation extends over an area of 20,000 square miles, of which 5200 have been closely covered with points for use in plane table surveying. Of this latter an area of 500 square miles has been completed on a scale of one inch to the mile, and an area of 2400 square miles on a scale of two inches to the mile. The revision of the older portions of the triangulations has now been completed, and the whole of the work corresponds to the demands of modern science. Certain of the stations on the sand-hills formerly occupied by the observers having disappeared, it has been ascertained that these hills travel progressively in the same direction, W.N.W. to S.S.E., which is that of the prevailing winds in this locality. The rate of progression appears to be about fifty feet per annum; and this remarkable sand-wave, which has never yet been effectually resisted, notwithstanding nu-

merous attempts by growing grass and trees on the sands themselves, has gradually overwhelmed the villages it has met in its course. The tidal observations made by the survey in the Gulf of Kutch can only be satisfactorily carried out by setting up the gauges on shore, over wells sunk near the high-water line, and connected with the sea by iron piping. The wells are twenty-two inches in diameter, and the piping two inches, which dimensions do not materially retard the tidal phenomena.

GEODETIC SIGNALS USED IN THE ADIRONDACK SURVEY.

In his interesting report on the survey of the Adirondack wilderness of New York, Mr. Verplanck Colvin explains the construction of a very simple signal which was used by him with success to replace the expensive heliostat. This arrangement was constructed of a vertical shaft, over which was suspended by wires four square sheets of ordinary highly polished tin, from which sheets respectively others were suspended at various angles with the horizon. When the sun was about rising or setting, the reflection from the surface of the vertical sheets of tin were sufficient to make this signal visible at a distance of twenty miles, and that, too, in every direction; since by the action of the wind this arrangement was kept constantly in rotation. Mirrors of glass were at first tried, but were too easily broken in transportation, while the sheets of tin were carried safely to all positions. In the survey of so rough a country as the Adirondack region, the delicate and expensive instruments required in the exact work of the Coast Survey could scarcely be employed, except at an unjustifiably great expense. Mr. Colvin's survey looks to the rapid preparation of sufficiently accurate maps of that region, based upon geodetic triangulation and barometric determinations of the altitudes of prominent points.

THE SARANAC EXPLORING EXPEDITION.

For the purpose of increasing the attractions of the ethnological exhibition at the Centennial, undertaken by the Indian Bureau and the Smithsonian Institution, the Secretary of the Navy directed the United States steamer *Saranac*, bound on a cruise to the North Pacific, to take on board at San Fran-

cisco Dr. Emil Bessels, the well-known surgeon of the *Polaris* expedition, to have charge of obtaining a full representation of the manners, habits, etc., of the Esquimaux of the northern possessions of the United States. He was accompanied by Lieutenant Maynard, of the Navy, who was the member of the commission ordered by Congress, two years ago, to investigate the trade of the north, and the relations of the Alaska Commercial Company to the natives.

The proposed plan of the cruise of the steamer was to proceed first to Sitka, for the purpose of coaling, and to collect such articles as could be found in that vicinity; thence to Kodiak by way of Cook's Inlet; then to Nunivak and the Pribylov group. Here a week was to be devoted to the investigation of prehistoric dwellings at the northeast end of Nunivak Island. After that the vessel was to proceed to St. Lawrence Island, and thence to the Seniavine Strait, southwest of Aracan Island, where the natives have an extensive trade with Americans by way of the Diomedes, they being of American extraction, and having left America at a comparatively recent date. It was also proposed to stop at the Diomede Islands, which are said to be thickly populated by Esquimaux, and afterward at Cape East, where a very large number of these people are reported to exist. Having investigated the Siberian coast, she was to pass over again to the American shore to Point Hope, which next to Nunivak may be considered as of the greatest importance in regard to ethnological significance. The northernmost point of the northwest coast to be touched at was Cape Lisburne, with its interesting deposits of palæozoic fossils, where a large harvest was expected. Should circumstances permit, the attempt was to be made to reach Wrangel's Land, which has never been landed upon. On the way back it was intended to stop at King's and Sledge Islands, where several native settlements are known to exist; and, after having passed a number of days among these Hyperboreans, the vessel was to proceed to Unalashka, whence a number of minor excursions were to be made, with the aid of the steam-launch accompanying the vessel, to the Chika Islands, in Akutan Pass. This was to have been the final work before her return to San Francisco.

The expedition was well provided with surveying and

magnetic instruments, with photographic apparatus to obtain portraits of the natives, and a complete outfit for the collection of specimens of natural history. The scientific operations were intrusted to Dr. Emil Bessels, while Lieutenant W. Maynard had orders to continue his investigations in regard to the seal fisheries and the fur trade. The Indian Office placed $3000 at the disposal of the former to procure ethnological specimens for the Centennial Exhibition. It was also the intention to bring some natives of the different hyperborean tribes to the United States to be exhibited at Philadelphia, in order to have an opportunity for studying, with more leisure than a brief stay in their country would afford, their language, mythology, etc.

Unfortunately the cruise came to a sudden end. The *Saranac*, after having left San Francisco, encountered heavy headwinds, and had to run into Nanaimo, Vancouver Island, to coal. After a day's delay, she left this place on the evening of June 17th, and in attempting to enter Seymour Narrows, at about 8 o'clock the next morning, she struck the well-known rock near the middle of the channel, and sank in less than an hour. The accident was caused by the fact that the vessel would not obey her helm readily. The strong current, having at the time a velocity of about seven knots per hour, carried her with crushing force against the sunken rock. Hardly any thing could be saved, but owing to the excellent discipline no lives were lost. The officers and crew, numbering 173, landed safely with the ship's boat on the shore of Vancouver Island; but as the cliffs were too steep to afford a good camping-ground, both provisions and camp were transferred to Valdisc Island, which was found to be more suitable. In the mean time the executive officer of the lost vessel was dispatched to Victoria, with a boat's crew, to obtain assistance. After the lapse of five days of continual rain, during which the shipwrecked mariners were almost without shelter and on very scanty rations, the English man-of-war *Myrmidon* made her appearance, followed by the H. B. C. steamer *Otter*, to convey the officers and men to Victoria. The courteous and generous treatment of the party by the English naval officers can not be too highly spoken of.

EXPLORATIONS UNDER DR. HAYDEN IN 1875.

The United States Geological and Geographical Survey of the Territories, under the direction of Professor Hayden, during the season of 1875 continued its work of the two previous seasons in Colorado, completing the southern and southwestern portions, including a belt fifteen miles in width of Northern New Mexico and Eastern Utah.

The entire force of the survey was divided into seven parties for special duty, four of which were assigned to specific areas, for the performance of topographical and geological work. One party attended to the primary triangulation, a second collected photographic views of the most interesting scenery and ancient ruins, while a third transported the supplies to the various districts.

The areas for exploration the present season were much farther from the base of supplies than heretofore, rendering the labor greater, and causing great loss of time in traveling to and from these bases. Yet the amount of topographical and geological work accomplished has not been exceeded in any previous year.

As heretofore, the starting-point was at Denver. The first or southern division operated in Southeastern Colorado. It was composed of A. D. Wilson, chief topographer, directing; Franklin Rhoda, assistant topographer; Dr. F. M. Endlich, geologist, with two packers and a cook. The district surveyed by this party embraced an area of 12,400 square miles. Within these limits Mr. Wilson made one hundred and forty-three stations on the more commanding peaks.

A system of triangles was extended over the whole area, while at the same time the topographical sketches and angles were taken, barometrical readings were made at all occupied points, at all camps, passes, and other places of note visited during the season. Many of the stations have been carefully connected in height by fore and back angles of elevation and depression, to be used as a check on the barometric heights, while the height of all located points has been determined by a system of angles of depression and elevation.

The district assigned to this division for the summer of 1875 joined on to the south borders of that surveyed in

1873 and 1874. The 104° 30′ longitude formed the eastern, 108° longitude the western, and 36° 45′ north latitude the southern boundaries. About 12,400 square miles were contained in the district.

A plan for the most rapid and successful completion of the work undertaken was prepared by Mr. Wilson, and subsequently carried out as proposed. This district contained the foot-hills sloping eastward from the Front Range, the southern continuation of the Sangre de Christo Range, the southern end of the San Luis Valley, the extension of the La Plata Mountains, and the lower country of the Rio San Juan and its tributaries. A small portion of the sedimentary eastern foot-hills was first surveyed, and the work then carried westward to the mountainous vicinity of the Upper Rio Grande. Instead of forming a well-defined, sharply limited range, the mountains south of the Rio Grande are formed by a high plateau with numerous isolated peaks. Both plateau and the peaks mentioned are volcanic, showing the characteristic regularity of flows prevalent there. From the position of volcanic beds composing the higher peaks, it may be inferred that at one time the summit of the plateau extended to a considerably higher altitude than at present. Toward the southwest it drops off suddenly into the lower country containing Rios Piedra and Pinos. Presenting a line of steep, rough mountains, formed in part by the abrupt termination of the plateau, in part by the peaks above mentioned, the former contrasts strongly with the rich land in the valleys of the two rivers. Here, as at so many points in the districts surveyed by the southern division, the geological features determine the orographic character. With the plateau end, the volcanic beds and the sedimentaries of the cretaceous age set in. But few stratigraphical disturbances have changed the relative position of the beds, and the country, therefore, shows regular features. Long lines of high ridges, abrupt on the north side, sloping more gently toward the south, extend from east to west, and are cut by the drainage of the San Juan. Eastward the edge of the plateau recedes, losing at the same time some of its roughness, and a broad expanse of comparatively low bluff country appears. Rich valleys, partly timbered or covered with grass, follow the course of the larger streams, owing their formations to the

rapid erosions and ready disintegration of the shales belonging to Cretaceous No. 2. Springs containing an unusual amount of mineral ingredients, some of them hot, occur in these valleys. Owing to the slight southerly dip of the cretaceous beds, this formation claims a considerable area of the region, extending from the Rio Animas eastward to the border of the district. Above the well-determined strata of Nos. 2 and 3, a series of shales and sandstones set in, in which no characteristic fossils whatever were found. They reach a thickness of about three thousand feet, and contain coal at a number of points. It will not be possible to determine their geological age with any degree of certainty, until careful comparison of the parallel formations observed by Mr. Holmes and Dr. Peale can be made. The absence of fossils is greatly to be regretted; but none were found, although many square miles were traversed containing the series. Speaking with the reserve that imperfect comparison of the notes taken dictates, it would appear that the Trinidad coal-bearing series is parallel to this one.

After having completed the survey of this lower region along the Rio San Juan and its tributaries, the work was continued to the extension of the La Plata Mountains. Here again volcanic rocks were met with, identical in every respect with those farther north and west. Here, as well as previously on the headwaters of the Pinos and Piedra, evidence of former glaciers was found. Considerable areas showed the grooving and striation of rocks *in positu*, produced by the motion of ice and boulders. Deep cañons were cut into the volcanic conglomerate occurring there, that had not preserved grooving and striation however, owing to the rapidity with which it yields to the effect of atmospheric influence. A gentle slope eastward of the volcanic rocks, that there reached to the youngest member of the group—basalt—gradually merged into the San Luis Valley. Affected by local basaltic eruptions, as well as by the easterly dip of the volcanic beds, the drainage on the west side of this valley presents some interesting features, consisting in sudden curves northward. Northward, the unbroken flows of basalt continue on the west side of the valley until Rio Alamosa is reached, where they end and drift begins. A number of volcanic bluffs, trending nearly north and south, sep-

arate this portion from the valley through which the Rio Grande runs, after making its turn southward, west of Fort Garland. This region, geologically, is more interesting than the western one, on account of the evidence furnished demonstrating the existence of two very large lakes at the close of the volcanic activity there. The two were connected by a narrow strip of water south of Fort Garland, and the lower one extended southward nearly to the Rio Colorado. At that time, too, the course of the Rio Grande was different from its present one. By the formation of a narrow cañon in the basaltic beds, the course of the river was deflected, the lakes drained, and the topography left very nearly in the shape we now observe it. The accurate determination of all the points connected with the existence of these lakes offers no material obstacle, but requires far more time than could be bestowed upon it in the regular course of the survey.

Separating the eastern foot-hills and the great plains from the San Luis Valley is the southern continuation of the Sangre de Christo Range. Several peaks of this range rise to an elevation of nearly fourteen thousand feet, while many of them reach thirteen thousand feet above sea level. Here again metamorphic rocks set in, containing indications of metalliferous veins. Sedimentary beds, belonging to the carboniferous and cretaceous ages—the latter only on the eastern slope, however—rest against the metamorphic "core" of the range. Volcanic eruptions of the trachytic series have occurred, and show an arrangement parallel to the general course of the chain. A more or less isolated group of peaks lies north of Fort Garland, termed the Sierra Blanca. Passes are both north and south of it—Mosco Pass, and the Sangre de Christo and Abeyta Passes. While cretaceous beds overlying the carboniferous, and showing considerable disturbances, slope off from the range toward the eastward, their area is somewhat limited, as the lignitic group there again makes its appearance in the Raton Hills and north of them. Lithologically this is identical with the one observed on the Rio San Juan. Comparisons of the succession of strata and relative thickness, etc., will be found in the report for 1875. The age of this group has for some time occupied the attention of geologists, and given occasion

for dissenting views. It is highly probable that the results obtained during the past season will admit of a definite decision with regard thereto. They will at least be entitled to more consideration than those of explorers who have merely traveled over a limited area, as so large a continuous district containing the formation has been examined. It is not possible at present to state positively what these results will be, but from the observations taken in the field it can be deduced that the age of the lignitic group near Trinidad is *not* cretaceous. A full discussion of this important subject will be found in the report for 1875.

Upon the completion of the examination of the just-mentioned group, the work of the season was connected to the north and northeast with that of 1874, and therewith finished. On October 12th the party returned to Denver, having fully accomplished the purpose for which it was sent out. Important and useful information has been obtained regarding the mineral and agricultural resources of the district, and data have been obtained for the preparation of a topographical and geological map of the area surveyed.

The southwestern division was conducted by W. H. Holmes as geologist, with G. P. Chittenden as chief topographer, and T. S. Brandegee as assistant topographer. Mr. Brandegee acted as botanist also.

The area assigned to this division is bounded on the east by the work done by Mr. Wilson in 1874, or a line about on the meridian of 108° W. long., on the south by the parallel of 36° 45′, on the west by meridian 109° 30′, and on the north by 37° 30′ N. lat. These boundaries included an area of about six thousand five hundred square miles. An area of about five hundred square miles was surveyed on the eastern base of the mountains on the outward march. Here Mr. Chittenden made about twelve stations, connecting with the former work, and completing the sheets to the proposed eastern line of the survey.

The easternmost line of the district assigned to this division was over four hundred miles from Denver. The party arrived there on the 30th of June, and commenced work immediately.

The work was generally done by means of the plane table, and reinforced by both vertical and drainage sketches from

all the stations, and also by time meanders of all the main streams, and generally by a running sketch of the routes traveled. The main stations averaged *one to every seventy-five square miles* of area.

By meandering, Mr. Chittenden surveyed the San Juan River, the La Plata, the Mancos, and the Dolores, all of them considerable streams, and besides these also the McElmo and Montezuma Creeks, which, though well-defined stream-beds, contain no running water. These last-named dry rivers are each upward of seventy-five miles long, and for a considerable part of their course are in deep cañons. In the meanders he made a trigonometric location as often as once in ten miles.

The great trouble in working was lack of water. They were often obliged to ride out ten, fifteen, and even twenty miles from the rivers to make a station, and back again for camp, because outside of the rivers themselves there was no water at all.

In regard to the systems of working generally employed now in the different surveys west of the Missouri River, the plane table system, which was generally used this summer, is admirably adapted to a low, broken country where good "points" are abundant, and works also extremely well in a simple cañon country, where there are surrounding prominent points at not too great distances. But in a mountainous country it could not be used to any advantage, and was eventually abandoned in all the mountain work. In low, broken, and cañon country it is probably the best system that can be used; but in the ordinary rolling and mountainous country of the Northwest it will not repay the extra weight and time which its use entails.

In any but a very mountainous country a system of *meanders* seems to be almost necessary to make work on a scale of four miles to an inch complete. It is the abuse and not the use of the old odometer system that has brought it into so much discredit. If properly checked, the meanders give the more important portions of the country, as the traveled routes and principal rivers, the greater degree of accuracy which is their due. The third and only remaining system in use in the West is that generally employed on this survey, and formerly used both in the California Survey and in that

of the 40th parallel. It consists of a system of vertical and horizontal sketches, based on a rather elaborate triangulation, and checked by numerous angles both vertical and horizontal. This system is peculiarly adapted to a rolling or mountainous country, and in such a country can not be equaled by either of the other modes. It works well, too, in districts of different character, and is probably, on the whole, the best system on which to base work in the average country of the West. It should, however, be supplemented by good meanders of all the main roads and rivers. In the work of the survey this summer the three systems were employed, and the above remarks are the immediate result of the summer's observations.

The party completed about six thousand square miles in the West, being obliged after the trouble with the Indians to leave unworked a small corner in the northwest, which will require about five days to complete. This patch joins directly on to Mr. Gannett's uncompleted area, and lies entirely west of the Colorado line. In going to and from the work, six full weeks were spent in marching. Mr. Chittenden worked about six thousand five hundred square miles, and made eighty-four main stations.

The geological examination by Mr. Holmes was fruitful of most important results. His investigations were extended from Colorado into portions of Utah, Arizona, and New Mexico.

No previous study of this region had been made, excepting that by Dr. Newberry in 1859, of which nothing has been published up to this time.

In 1874 Dr. Endlich examined the district lying to the east, so that Mr. Holmes took up the work where he left off at 108° W. long., and carried it without difficulty to 109° 30′. In general the geology is not greatly complicated. The section of stratified rocks exposed extends from the lignitic series to the carboniferous, including about two thousand feet of the former, and slight exposures merely of the latter. About eight thousand feet of strata, therefore, passed under examination. Of other rocks, there are four small areas of trachyte, one limited area of metamorphic rock, and a few unimportant dikes.

Beginning at the east, Dr. Endlich's section on meridian 108° includes the entire series, beginning with the lower

carboniferous in the north and extending up into the tertiary at the south. The strike is east and west, the dip south from 5° to 45°. Working to the westward, Mr. Holmes found the whole series flattening out, *i. e.*, approaching a horizontal position. At the same time a gentle rise toward the northwest brings the cretaceous rocks to the surface, or at least up to the general level of the country. The lignitic group is, therefore, confined to the southeast. From Station 1 an outcrop of the light-colored sandstones, belonging to the base of this series, could be traced along its entire course through his district.

The heaviest seam of coal examined in these beds is twenty-six feet in thickness. It is rather light and impure on the surface, but probably of moderately good quality. A number of less important seams could also be recognized.

West of the Rio La Plata the upper cretaceous beds are raised to a higher plain by a slight monoclinal fold, after which they spread out to the west, forming the Mésa Verdé. This plateau extends nearly to the San Juan on the south, west beyond the Rio Mancos, and north to the middle of the district, an area of more than seven hundred square miles. On these three sides the Mésa breaks abruptly off in lines of irregular escarped cliffs, generally from one thousand to two thousand feet in height.

The striking features of this series are the exposure of two horizons of massive sandstones. The upper forms the top of the Mésa, the lower, one thousand feet below, produces a subordinate shelf. Shales intervene between the sandstones of the lignitic and the upper sandstones of the Mésa, and between these and the lower sandstones. Around the base of the Mésa the lower cretaceous shales outcrop. The belt covered by these is narrow, and is followed by the hard sandstones of the Dakota group, which is very persistent here as elsewhere, and occupies the higher level of the entire Mésa country to the west and north. The Jurassic strata and the "Red Beds" are exposed in the sides and bottoms of the numerous cañons and stream courses, the latter only in the greater valleys, and in patches about the bases of the trachytic areas. The Jurassic section is, in the upper part, almost identical with the corresponding series in other parts of Colorado, but at the base has a larger de-

velopment of soft sandstones and marls. The identification rests upon the analogy of position and lithology. The "Red Beds" are massive sandstones and conglomerates as usual.

The only important mountains are the Sierra La Plata. They lie toward the northeast, and are principally of carboniferous rocks, so highly metamorphosed as to have lost all apparent structure. A large number of rich lodes of gold and silver have been recently discovered in this group about the sources of the Rio La Plata, and an extensive placer bar is located near its exit from the mountains.

In the extreme northeast corner of this district there is a group of trachytic buttes, including Lone Cone, which belong to the San Miguel Mountains. West of the Mésa Verdé, almost in the centre of the district, stands the "Late" group, of which Ute Peak is the culminating summit. It covers an area of some forty square miles, and is simply a mass of trachyte pushed up through and poured out over the floor of the Dakota group.

In the extreme southwest corner, principally in Arizona, are the Sierra Carisso, identical with the "Late" in nearly every respect, differing only in having carried up portions of the carboniferous rocks about their base, while a fragment of the same beds is caught up in the centre of the group.

Of the 6000 square miles, 5700 are of sedimentary rocks. Two hundred and thirty of these, in the southeast, are of the so-called lignitic; 800, chiefly included in the Mésa Verdé, belong to the upper cretaceous; and the remaining 4900 to the lower cretaceous, and such of the earlier periods as are exposed in the crooked and narrow valleys, and about the trachytic groups. In the cretaceous series Mr. Holmes examined a number of seams of workable coal, procured fossils in ten distinct horizons, and expects to be able to identify these horizons with such corresponding ones on the Atlantic slope. The section obtained is the most complete and satisfactory made in Colorado up to this time. The trachyte areas include about 250 square miles, and seem to present no remarkable or unusual features.

The prehistoric remains in the cañons and lowlands of the southwest are of great interest, and the study of them by Mr. Holmes was as complete as possible under the circumstances. Many cliff-houses, built in extraordinary situations, and still

in a fine state of preservation, were examined. A good collection of pottery, stone implements—the latter including arrow-heads, axes, and ear ornaments, etc.—some pieces of rope, fragments of matting, water jars, corn and beans, and other articles, were exhumed from the débris of a house. Many graves were found, and a number of skulls and skeletons, that may fairly be attributed to the prehistoric inhabitants, were added to the collection.

The Western or Grand River Division consisted of Henry Gannett, topographer-in-charge, W. R. Atkinson, assistant topographer, A. C. Peale, geologist, two packers, and a cook.

The district assigned to this party lies between the parallels of latitude 37° 52′ and 39° 15′; is limited on the west by the meridian 109° 30′, and on the east by the western limit of the work of last year, approximately the Gunnison and Uncompahgre Rivers. This embraces the country drained by the Uncompahgre and Dolores Rivers and their branches.

The party left Denver on June 7th, and on July 3d commenced work. They worked uninterruptedly until August 15th, when the work was brought to a sudden close by the Indians.

The work was carried to the western line of Colorado, toward the northern end extending 25 or 30 miles into Utah, and reaching the north and south lines throughout, except in the southwestern part. The total area surveyed is about 6000 square miles. In doing this 74 stations were made.

The country is extremely diversified. The Uncompahgre flows through a broad valley, fifty miles in length by about twenty in width, almost perfectly flat, and very dry. The elevation is 4500 to 6000 feet. The soil is poor, and vegetation, except in the river bottom, very scanty.

Between the Uncompahgre and Dolores is a high ridge, whose axis is parallel to the course of the river, *i. e.*, about N. 30° W. It has a long, gradual slope to the Uncompahgre valley, while it breaks off sharply and steeply to the Dolores. The average elevation of the crest is 8000 to 9000 feet. Most of this country is well timbered with heavy pine, quaking aspen, and some spruce. There is also considerable open country, which is covered with luxuriant grass.

The Sierra La Sal is a short, isolated range of mountains, just west of the Dolores, separating it from the Grand River.

The direction of the range is about north and south, its length about fifteen miles, and the elevation of the summits 12,000 to 12,500 feet.

The Grand River, from the mouth of the Gunnison to that of the Dolores, is alternately in open valley and low cañon. On the south the river hugs the edge of the plateau closely, while on the north low, open desert country extends about fifteen miles back from the river. This desert country extends down the Grand and across to the Green, forming the Great Plateau in which these streams and the Colorado cut their cañons.

South of the Sierra La Sal are fine valleys, extending nearly to the head of the Dolores. Farther west the country is a plateau, without water, covered with sage and pinion pine, and cut by numberless dry cañons.

The geological features of the district surveyed by the Grand River Division during the season of 1875 are comparatively simple, there being no great uplifts nor many local disturbances. The sedimentary formations represented are all included under carboniferous, red beds (triassic ?), Jurassic, and cretaceous. Exposures of metamorphic rocks are seen in several parts of the district, limited mainly to the bottoms of cañons, the streams having cut through the overlying sedimentaries. The eruptive areas are also limited. In the southern part of the district there are the overlapping edges of various trachytic flows, whose sources of origin were in the Uncompahgre Mountains still farther south. Besides these there are three distinct centres of eruption: viz., the Lone Cone group of mountains on the south, the Abajo Mountains in the southwest, and the Sierra La Sal Mountains toward the northwest. These are of porphyritic trachyte, and have been pushed up through the cretaceous layers which dip gently from them. The greater part of the district, however, is covered with sedimentary rocks, generally horizontal, or, if dipping, but little inclined. In these beds the drainage is outlined by cañons which are from a few hundred to over a thousand feet in depth. During the summer months these streams are dry.

Leaving the Los Pinos Indian Agency, the first work was on the south side of the Gunnison River, in a narrow strip of country lying between Mr. Gannett's district of 1874 and

that of Mr. Wilson for the same year. The rocks here are trachytes, interlaminated with tuffs in horizontal layers. They rest partly on metamorphic rocks and partly on the remnants of cretaceous sandstones. Previous to the outpourings of these trachytes, the country was evidently subjected to considerable erosion, the sandstones being in many places entirely removed, exposing the gneissic rocks upon which they were deposited. Going westward toward the Uncompahgre River, the volcanic rocks disappear, and rocks of upper cretaceous age show in bluffs on the east side. The weathering of these beds has produced a barren alkaline soil, in which there is no vegetation. In the immediate river bottom there is some good soil, but it is limited in extent. The course of the Uncompahgre is a few degrees west of north, and between it and the drainage of the San Miguel and Dolores Rivers, which has, approximately, the same direction, is a plateau-like country with a gentle slope to the eastward toward the Uncompahgre, and breaking off in benches on the Dolores side. Seen from the mountains, this plateau appears very regular, nevertheless it is very much cut up by numerous cañons, which carry water only in wet seasons. The floor of the plateau is composed chiefly of sandstone of the Dakota group (Cretaceous No. 1), underlaid by Jurassic shales and red beds (triassic ?), which rest upon metamorphic rocks, as seen in the cañons. On the western side of the plateau is a monoclinal fold, which in some places becomes a fault of 300 to 500 feet.

One of the most curious features of this region is a cañon extending from the Dolores River to the Gunnison River. It is evidently the bed of an old stream, which probably once flowed toward the Gunnison. At present there are in it two creeks, one a tributary of the Gunnison, and the other a branch of the Dolores, the latter the principal stream of the two. At the divide between them the cañon is about 1200 feet deep, 900 feet of gneissic rock and 300 of sedimentaries on the top. The dip is toward the east, and the creek, flowing in that direction, gradually gets higher and higher in the schists, and finally cuts through the overlying sandstones in which it joins the Gunnison. Toward the west the cañon rapidly increases in depth, until it is 3000 feet below the general surface. The stream on this side cuts across the

line of faulting of the west side of the plateau, and enters the red sandstones which incline westward. In these it joins the Dolores River. North of the cañon, between it and Grand River, the Dakota group, which prevails to the southward, is almost entirely absent, the red beds forming the greater part of the surface, which is here a maze of dry cañons. The country gradually falls off toward Grand River; the western line of faulting becomes a fold, and the eastern fold, which is also faulted in places, gradually becomes less. North of Grand River beds of upper cretaceous age appear, probably succeeded by tertiary as we go north. On the San Miguel and Dolores Rivers, and extending westward, the rocks are sandstones. There are broad folds extending across the country, whose axes are parallel, the general direction being north and south. Between the San Miguel and Dolores, the Dakota group forms the floor. Beyond the Dolores the red beds prevail, capped with isolated patches of Jurassic shales, and underlaid with beds of carboniferous age. The latter show but in few places. The drainage here has two general courses at right angles to each other. The main streams flow in a general northerly direction.

In the Sierra La Sal the prevailing rock is a beautiful porphyritic trachyte, which in some places has included masses of cretaceous shales. One of the most prominent peaks has a capping of sandstone, which was lifted up by the eruption of the mass, the base of the peak being entirely of trachyte. There are evidences of glacial action here. Northwest and west of the group the red beds have the Roches Moutonnés form, beautifully seen from the summits of the mountains.

The Abajo Mountains are of porphyritic trachyte similar to the Sierra La Sal, as are the mountains about Lone Cone, which properly belong to the district assigned to the San Juan Division.

The work of the Fourth Division, directed by G. R. Bechler, extended over a large area, situated between meridians 104° 30′ and 106° 30′, and parallels 38° 40′ and 40° 30′; or from the foot-hills of the Rocky Mountains to the Upper Arkansas and Eagle Rivers, and from a point six miles south of Pike's Peak to within fifteen miles of Long's Peak.

In this district the entire Middle and South Parks are located, and three of the large rivers of the west—the Arkan-

sas, Grand, and Platte Rivers—together with several of their large tributaries, have their origin. The principal branches are the Blue, Snake, Williamson, and Frazer Rivers on the west slope, and Tarryall, Fountain of the Bouillie, Bear, Clear, St. Vrain, Boulder, Thompson, and Buckhorn Rivers on the eastern slope.

The main Rocky Range and its minor ranges are in this district peculiarly complicated, for the latter, at times, on account of their height and magnitude, seem to lose their subordinate character and become independent ranges, while the main range contains groups or clusters of peaks so complicated in their form and connection that it requires close observation on the part of the topographer to lay down the true drainage.

Among the minor ranges, the Park, Williams or Blue River, Gore's, Tarryall, and Platte River ranges rank in height among the largest, while for extreme ruggedness the Gore and Tarryall Mountains can not well be surpassed. In this district the great mining industries of Colorado are found.

The geographical features of this area are as follows: Between the Argentine and Georgia Passes a ridge of mountains leaves the main chain and follows a course about southeast, and connects with the mountains near the Pike's Peak group on its west side. This is the Tarryall Range, a rugged and abrupt granite wall, with several peaks over 12,500 feet in height, and most of the others rising above timber line. The greatest depressions in this range are where the Tarryall and South Platte Rivers break through in cañons, and where the Ute Pass and Kanosha Pass afford an entrance to the South Park. To the east of the Kanosha Pass, a few miles, the Tarryall Range separates into two ridges, which run nearly in an eastern direction. The northern ridge borders the south side of the North Platte River, and is called the Kanosha, or Platte River Range. In this ridge volcanic peaks are found in great numbers. The mountain ranges in this portion of Colorado continually throw off spurs which are remarkable for the deep gorges which have been worn down their sides.

After completing the survey of Platte River, Tarryall, and the South Park districts, Mr. Bechler ascended the Ar-

kansas Valley, crossed the Tennessee Pass, and examined the country that lies between the Eagle and Blue Rivers, of which very little was known. This territory is bounded on the south by the imposing mountain masses of the Mount Lincoln group, and on the east by the cliff walls of the Blue River Range, and on the northeast by Gore's Range, with its needle-shaped peaks extending for twenty miles like sharp pinnacles.

In completing the survey of this district, Mr. Bechler joined, by his topographical work and triangulation, three separate surveys of previous years.

Crossing Gore's Range and the Blue River, Mr. Bechler passed through the Middle Park and over the Boulder Pass to the sources of the Big Thompson Creek, an important stream rising on the east side of the Long's Peak group. Much excellent work was done in the ridges or hog-backs at the east base of the mountains, thus bringing the season's labors to a most successful termination. One hundred and six stations were made, barometrical elevations were four hundred and fifty, and the number of elevations taken with the gradienter were about six thousand.

The party under Mr. Gardner had made but four stations when it was prevented from further prosecution of that duty by Indians. One of the stations occupied was very important, viz., the Sierra La Sal Mountain, which enabled Mr. Gardner to secure an excellent set of observations, thus extending the triangulation far into Utah, and connecting our eastern work with the great Colorado River of the West.

During the latter part of the season of 1874 Mr. W. H. Jackson, the photographer of the United States Geological Survey, in connection with Mr. Ernst Ingersoll, visited the southwestern portion of Colorado for the purpose of photographing the ruins which rumor has placed in the cañons of the Mésa Verdé and about El Late. The season was far advanced, and there was but little time for investigation, yet the eight days that were actually devoted to the subject brought to light a group of ancient habitations, so novel in their construction and position that they have excited a very general interest. The results of the trip, as published in the correspondence of that time, and in Bulletin No. 1 of the Survey, have already been widely distributed. The il-

lustrations secured by photography, and then reproduced by photo-lithographic processes, have done much to popularize and render familiar the leading features of the subject, showing as they do all the phases of the eccentric methods of these ancient builders, have made them an authority, and they have already been reproduced in a number of late publications.

The first trip proving so successful, Mr. Jackson was dispatched again this season to the same region, with instructions to ascertain as far as possible the extent and distribution of these ruins north of the present Moquis Pueblos. Associated with him in the enterprise was Mr. E. A. Barber, special correspondent of the New York *Herald*. A guide, two packers, and a cook constituted the whole party; and then, with six weeks' supplies laid in, the party started out from Parrott City, at the head of the Rio La Plata, August 27th, the general course being down the Rio San Juan to the De Chelly, up that to near Fort Defiance, and then over to the seven Moqui "Cities." Returning, they crossed the San Juan at the mouth of the De Chelly, and traveled northward to midway between the Sierra Abajo and La Sal, and then returned to the starting-point across the heads of the cañons which run southward to the San Juan.

The Upper San Juan, Mésa Verdé, and El Late regions came within the area assigned Mr. W. H. Holmes, who, in addition to his geological investigations, made a special examination of the archæology of his region, bringing out with his ready and artistic pencil even more wonderful ruins (of the same general class however) than were found by Mr. Jackson the previous season.

Traveling westward to the head of the wash of the McElmo, a day was spent in the further investigation of that interesting locality. A number of new ruins were discovered, but in no way differing from those already figured. The extreme heat of the atmosphere and the aridity of the country prevented more than a superficial examination of the many side cañons which debouch into the main one, only enough to determine satisfactorily that ruins were to be found only in those cañons which had alluvial bottoms or in the near vicinity of tillable land. This fact held good in the other regions, for in no case could a single vestige of

any habitation be found in the sterile, rocky gorges any way removed from cultivatable ground. Their ideas of good farming land would hardly come up to that of an Eastern farmer, yet a strip of bottom land only fifty yards in width at the bottom of their deep cañons would yield maize enough to subsist quite a town. The supposition that they were an agricultural people is strengthened by the fact that in the vicinity of any group of ruins there are also a number of little "cubby-holes," too small for habitations, and very evidently intended for "caches," or granaries, and the large towns contain small apartments that must have been used for the same purpose.

The only known water in the country, short of the San Juan, over forty miles distant, was on the Hovenweep, near the town which was discovered last year, thus necessitating the retraversing of so much of the country. A day spent in some of the tributary cañons developed no remains of any importance, although every little side cañon contains traces of former occupation by the town-builders. To the west of the Hovenweep is a high, level plateau separating it from the cañons of the Montezuma, and running north and south from the waters of the San Juan to those of the Dolores. Upon this were found the remains of many circular towers, all of about the same size—twelve to fifteen feet in diameter. They are generally almost entirely obliterated; but in two or three cases portions of the wall twelve to fifteen feet high, of well-built masonry, were found. This arid sandstone mésa, a thousand feet above the surrounding valleys, does not contain a spring or any water whatever, except such as collects in the water-pockets during a shower. The soil upon its surface is thin, and in places is blown off clean to the bed rock. Grass, cedar, and artemisia flourish; in fact, it is most excellent grazing land, and, as cultivation was out of the question, these people must have had herds of sheep or goats, which they brought up here to graze during the winter months, just as the Utes and Navajos do at the present time, and these towers were built as places of refuge or residence for their herders.

Eight and ten miles below the Hovenweep town are two groups of ruins worthy of note. The first is built upon an almost perfectly rectangular block of sandstone which oc-

cupies a prominent position on a spur of the mésa. It is thirty-eight by thirty-two feet square, and twenty feet in height, as true and as level as though set by masons. The summit is entirely covered with the work that was built upon it, very evidently for merely defensive purposes, for directly at the foot of the rock at its south side was the habitation of the family. A line of wall forty feet square incloses a space, within which was another building resting against the rock itself, the roof of which served as a means of access to the rock above. Two miles below, where the McElmo comes in, and upon the point of the mésa, are other similar ruins, but built much less regularly. Upon one of the faces of the rock is an inscription, chipped in with some sharp pointed instrument, and covering some sixty square feet of surface. Figures of goats, lizards, and human figures abound, with many hieroglyphical signs. The top of the mésa afforded much food for speculation in the interesting remains there discovered. The extreme point was a perfectly flat, level table, fifty by one hundred yards in diameter, with perpendicular walls of from fifty to one hundred feet on all sides, excepting the narrow neck which connected it with the main plateau. Across this neck a wall had been built to keep off either human or beast, and rendered the place perfectly isolated. Inside, nearly the whole space was subdivided into small squares and double-walled circles formed by slabs of stone set on edge, each square about three by five feet. The supposition has always been that these were burial places. They were dug down upon to a considerable depth without discovering any remains; and as the soil was thin and light, so that the labor of excavation was easy, a number of the squares were cleaned out to the bed rock beneath, which in some cases was not more than a foot below, but without discovering any thing more than that in every case the earth had been burned and a thin layer of charcoal remained. The question arises as to whether these people might not have been cremationists.

The Rio San Juan at the mouth of the McElmo is a stream averaging one hundred feet in width and three to five in depth, flowing in great curves that almost touch upon themselves again, and bordered with dense groves of cottonwood. The bottoms are from one to three miles in width, and

run back over sage-covered benches to the sandstone bluffs, picturesque in outline and color, which rise from five hundred to one thousand feet above the river. They gradually close in upon the stream, until it is finally lost in the great cañon below the mouth of the De Chelly.

Twelve or fifteen miles down the river brought the party to the first important ruins, although the older, almost unrecognized "indications" were abundant every where. At that point the bench land juts up over the river, and almost upon the brink is a quadrangular structure one hundred and sixty by one hundred and twenty feet square, with a small open court facing the river. A singular feature in its construction was a semicircular apartment in the centre of the building and rear of the court, about the outer circle of which was ranged a series of seven other apartments, each about four by six feet square. There were six other rooms averaging thirty-five by fifty feet. Under the bluffs and almost overhanging the stream were a row of little cave houses. Other cave houses were niched in the cave-like recesses of the bluffs for some distance above and below.

Some ten miles farther and the bordering bluffs came down quite near the stream, in some places overhanging it. Cave and cliff ruins occurred frequently in them. Upon the south side of the river an important cave ruin was discovered, which was quite remarkable in its way. Imagine a perpendicular bluff nearly three hundred feet in height, the upper half of which is a firm white sandstone, and the lower half a dull red, soft and friable variety. Time has excavated an almost perfectly hemispherical cave from this bluff, equally divided between the two kinds of rock. It is two hundred and fifty feet wide, two hundred feet deep, and the same from top to bottom at its outer face. Midway from top to bottom, and running completely around the half circle, which formed the back of the cave, are two benches, upon the upper of which is built the town or series of rooms, two hundred feet in length in the aggregate, the lower serving as a walk or promenade, from which access could only be had by ladders. A little to the left of the centre is the principal building, consisting of three rooms, each two stories in height, and now standing twelve feet high. Adjoining it on the right is a long row of twelve apartments, built as a solid block, and

on the left an open space of sixteen feet, and then another small building. In the open space were four holes, four inches in diameter and twelve deep, drilled into the rock, serving evidently as post holes for a loom. All the rooms have been burned out clean, so that not a vestige of woodwork remains. The walls are remarkably well preserved, the adobe mortar on the inside still retaining the impression of the delicate lines on the thumbs and fingers of the hands of the builders. Impressions of the whole of the hand were frequent, showing it to be small and finely formed. Corn cobs and pieces of pottery were found imbedded in the mortar. In the centre of the larger rooms, beneath the débris, were found the fire-places, circular excavations, which still retained the charred wood and ashes of aboriginal fires.

Perched up in one of the houses, under a great dome of overhanging rock, that distinctly echoed every word uttered, with a steep descent of over one hundred feet to the broad, fertile bottoms, handsome groves, and meandering course of the river, these old, old people, whom even the imagination can hardly clothe with reality, must have felt a sense of security that even the inroads of the barbarian Northmen could hardly have ruffled.

Omitting mention of large numbers of ruins which are clustered along the San Juan, the next important group discovered—for this is the first time any of these have been brought before the world—were those of the Rio De Chelly. The party reached this point August 7th, the very hottest portion of the year, in a region noted for the intensity of the scorching rays which radiate from its bare plateau of white sandstone. The average temperature throughout the day, in the sun, was 140°. The temperature of the water in the river, in the midst of a rapid current, was 88°, and that was the coldest water to be had.

The Rio De Chelly, for a distance of about thirty-five miles above its mouth, is so cañoned, and the wash—for the bed of the stream is perfectly dry the greater portion of the year—cuts from wall rock to wall rock so frequently, that it is impossible to travel up it, except in the bed, and that is so tortuous and rocky in places that it would be difficult, if not impossible. Making a detour to the right, the first opening into the cañon was reached ten miles above. In here an in-

teresting and extensive ruin was found, which was so well preserved that it seemed to have been vacated less than a score of years, and so near like the workmanship and manner of building of the present Moquis that it would not be difficult to imagine them lurking among the deserted rooms. This ruin was situated in a long cave-like bench, or mésa, running along the face of a perpendicular bluff, some fifty feet above its base, and has a total length of nearly 300 yards. The town was irregularly but compactly built, conforming to the rock upon which it is placed, the rooms arranged in a single row most of the way, but at either end bunching up to two or three deep. A ground-plan shows seventy-five rooms, with many little irregular "cubby-holes," with a total length of 548 feet. A few yards farther to the right are half a dozen detached buildings. Cisterns and reservoirs yet remain perfect enough to show their purpose. In the centre of the mass was a well-preserved circular apartment, a little below the general level of the others, that was probably an *estufa*. The great corrals were inside, between the houses and the bluff. Digging beneath the débris, several pieces of finely preserved pottery were found, the same finely ornamented and glazed ware of which the fragments are so universally scattered over the whole country. Beneath the centre of the town there was found in one group some whole jars, of about two gallons' capacity each, of the gray indented ware, but they were too fragile to transport upon pack-mules. Besides the pottery, many stone implements and arrow-points were unearthed. Another detour to the right, this time over an elevated plateau of white sandstone, across which were drifted great dunes of white sand, brought the party to the famous, so called, diamond-fields of Arizona, about which there was such an excitement in 1872. Lingering on its bare, red plain, upon which the sun beat with great intensity, only long enough to gather about a pint of garnets, which were of excellent quality and very abundant, camp was made at the foot of a side cañon which came in from the west, and was known as the Cañon Bonito Chiquito. Another group of ruins occurred here, not in a large town, but in scattered houses both up and down the De Chelly and Bonito. A marked feature were great reservoirs, in which there was, even now, abundant and excellent water. Two

or three miles below, in the cañon of the main stream, was a well-preserved two-story house, standing upon a bench elevated fifty feet above the valley, and overhung by a great roof of rock that effectually shielded it from the storms. Near by was a great natural reservoir filled with good water. Another five or six miles and the cañon of the De Chelly opened out into a great valley, from one to three miles in width, and extending up to the foot of the great cañon near Fort Defiance. Twenty-five to thirty-five miles above the Bonito are some peculiar table-rocks and monuments that form notable landmarks. The ruins are now scarce, only a few being met with in the caves at the side of the valley. The bottom lands bear the impress of very numerous ruins—adobie very likely—that are now almost entirely obliterated, and would hardly be noticed were it not for the broken pottery.

At the head of the valley of the De Chelly the trail turned off to the southwest just above the upper edge of the great white mésa. Taking only two others, Mr. Barber and Lee, the guide, and sending the remainder of the train back some fifty miles, where there was suitable grazing, Mr. Jackson continued over to the Moquis Pueblos, seventy-five miles distant, with only the photographic apparatus and supplies for five days. Tequa was reached by noon of the following day. As these Pueblos have been so frequently described and illustrated, the party spent only two days and a half among the six most easterly towns, viz., Tequa, Se-chum-e-way, Moqui, Moo-sha-neh, Shong-a-pah-wee, and She-paul-a-wee. Photographs of each of these were made, and also many sketches illustrating their habits, dress, and occupations. Collections of recent and ancient pottery and tools, and other objects of interest, were likewise secured. The comparison between the workmanship of the northern town-builders and these Moquis was very much in favor of the former. The highest perfection was reached in the cliff-houses of the Rio Mancos, where some of the houses were marvels of finish and durability; and then, traveling toward the Moquis, there is a gradual merging of one style into the other, from the neatly cut rock and correct angles to the comparatively crude buildings now inhabited.

Retracing their steps to the San Juan, at the mouth of the

De Chelly, the party now traveled northward toward the Sierra Abajo, up a stream known as Epsom Creek, from the water which is found near its head tasting and operating like that salt. The usual indefinite ruins which occur on the lowlands continued up this valley over thirty miles. To the west was a labyrinth of cañons running off into those of the Great Colorado, an examination of some of which discovered many cave and cliff houses and towns, all of the same general type as the others. The ruins gradually diminished as they approached the Sierra Abajo, and several days spent in the examination of the cañons and plateaus about it and the Sierra La Sal failed to bring to light any more evidence of their occupation.

Nearly opposite the Sierra Abajo, or Blue Mountains, as they are locally known, heads the great cañons and valley of the Montezuma, which empties into the San Juan. Here the bottoms of the cañons have once supported a very thickly settled community. There is almost a continuous series of ruins for a distance of twenty-five miles. This in one cañon only, but all the others contain numerous remains, chiefly in cliff houses and towns. In the main cañon, first spoken of, are two ruins notable for the size of the stones employed in their construction. In one, built upon a small isolated table-land in the middle of the valley, are stones set upon end, six feet in length by eighteen inches square, and ranged along the walls a distance of twenty-five or thirty yards. Another case is where stones seven feet in height (above ground), and twenty inches square, are standing perpendicularly about five feet apart, and form one side of a wall inclosing the ruins of a large, important building. Throughout the cañons every available defensive point has been utilized, and are now covered with the remains of heavy walls and large blocks of houses. Another singular feature was the number of holes cut into the perpendicular lower wall of the cañon for the purpose of ascending the rock, holes just large enough to give a hand and foot hold, and leading either to some walled-up cave or to a building erected above. Some of these steps ascended the nearly perpendicular face of the rock for 150 or 200 feet. On exposed surfaces disintegration has almost entirely weathered away the holes, while on more protected walls they are deep enough to still answer their original

purpose. The main western branch of the Montezuma contains the greater number and more important ruins of all the northern tributaries of the San Juan west of the Rio Mancos. Water was found in a few pools near its head and lower down, running along in a small stream a distance of two or three miles, when it sank again. The bottoms are rich, and the present Indians, Utes, who occupy the country, raise good crops of corn without irrigation.

The results of this trip was the collection of a large number of utensils, both modern and ancient, stone arrow and spear points, knives and axes, photographs, especially illustrative of the most important ruins, and numerous sketches of every thing of note, which will be brought out in detail in the regular publications of the Survey.

EXPLORATIONS UNDER MAJOR J. W. POWELL IN 1875.

The work of the Second Division of the United States Geological and Geographical Survey of the Territories, under the direction of Major J. W. Powell, has been in progress continuously since 1868 (during the earlier years under other titles), and prior to the present year an extensive region had been explored and partially surveyed. A stage of the work had been reached at which it was deemed best that a review of the geology should be made, for the purpose of establishing with greater accuracy the natural series of geological formations of sedimentary origin distributed through the fields of study already occupied, that the work of the several observers might be properly correlated. A small party was organized for this purpose, and led by Major Powell himself.

The main party under Professor A. H. Thompson, geographer of the Division, continued the work during the past season in the territory of Utah over an area of nearly 10,000 square miles, stretching from the Henry Mountains on the north to the Kaiparowits Plateau on the south, and from the Colorado River on the east to the Aquarius Plateau on the west.

A system of triangles projected from the Gunnison baseline has been connected with those made in earlier years from the Kanab base-line.

A primary hypsometric base-station was established at

Provo, on the Utah Southern Railroad, and a secondary base-station at Camp Supply, on the Dirty Devil River.

Plane-table methods were used in the topographic work. The plane table devised by Professor Thompson for this special work, after three years' experience, proves to be satisfactory, and is believed to greatly increase the accuracy of the work over the earlier methods of sketching and descriptive field-notes. Free-hand sketches and profile sketches were used as accessory methods in delineating the topographic features.

The classification of the lands begun in former years was continued during the past year; and it was found that of the lands surveyed during the past season, one fourth of one per cent. belongs to the first class, *i. e.*, lands which can be redeemed by irrigation; about fifty per cent. to the second class, *i. e.*, pasture lands; about nine per cent. to the third class, *i. e.*, timber lands; four per cent. to the fourth class, *i. e.*, mineral lands; and the remainder to the fifth class, *i. e.*, desert lands.

Geology.—Mr. G. K. Gilbert accompanied Professor Thompson's party as geologist. His prime subject of study was structural geology; that is, the magnitude and characteristics of the displacements by which rock-beds, originally level, have been brought to their present uneven condition. This study also involved an examination of the succession of strata, and incidentally full material for a geological map has been accumulated. A second and closely allied subject of study has been the eruptions that produced the Henry Mountains; a third has been the erosion by which the structure has been laid bare, and a fourth the Salina Creek unconformity.

The investigation at Salina Creek was of a special nature, and its bearings can not be briefly stated. Its result establishes a single point of geological history: namely, that an epoch of mountain growth, of which evidences are found in the Sevier and San Pete valleys, and in the Pah-van Mountains, occurred about the end of the Cretaceous period.

A line drawn from the Mu-si-ni-a Plateau southward to the eastern margin of the Aquarius Plateau separates a region of faults at the west from a region of folds at the east. Faults and folds are not distinct types of displacement, but

merely different phases of the same action, and it is usual to find them associated; but in this instance the faults are restricted in distribution. There is some reason to suppose that the folding was of more ancient date and extended through the whole area, and that the faults were superimposed over a part.

The folds are large and small, and of various forms. The larger are great elongated domes, from which the strata dip in all directions. The smaller dapple the surface of the larger like a ripple riding on an ocean swell. One of the chief swells extends from Thousand Lake Mountain, one hundred miles in a southeast direction, its remote end lying between the Colorado and San Juan Rivers near their junction. Its greatest width is thirty miles, and its height, if the crest had not been eroded away, would be 7500 feet. Its western slope is gentle and its eastern steep, so that the crest runs close to the eastern base. Another of the same breadth lies at the north of this, extending far into the basin of the San Rafael River. Its form is different, however, for its summit is broad and flat, and both of its sides are steep. The trend of its longer axis, too, has a different course (southwest), diverging sixty degrees from that of the other. A third, of even more imposing proportions, lies to the east of these, beyond the field of survey; and between them are domes of smaller size. All of these swells have been so demolished by the agents of erosion that there remain of them only low arches of rock encircled by parallel lines of inward facing cliffs.

In the regions of faults there are great displacements and small, and the small are often, just as in the other region, subsidiary features of the great. The earth's crust is there divided into a great number of oblong blocks with vertical sides, and these blocks have slipped out of their original places, some going up, some going down, many being tipped this way or that, as though an end had caught while it was moving. At the north the tops of the higher blocks have been worn away, and their positions and limits can be ascertained only by careful study of the rocks. But at the south the whole surface was covered by a thick lava sheet before it was divided into blocks; each block is protected from erosion by its cap of tough, hard lava; every mountain is a block upthrust, every valley is a block depressed;

and the whole structure of the country is exhibited in its reliefs.

The eruptions of the Henry Mountains are of exceeding interest. A description of a single one, though it will not stand for all, will serve to illustrate the type.

Mount Ellsworth is round, and its base is six or eight miles broad. The strata of the plain about it are horizontal on every side, except at one point. At its base the level strata become slightly inclined, rising from all sides toward the mountain. Near the mountain the dip steadily increases, until on the steep flanks it reaches a maximum of forty-five degrees. Then it begins to diminish, and the strata arch over the crest in a complete dome. But the top of the dome has cracked open, and tapering fissures have run out to the flanks, and they have been filled with molten rock, which has congealed and formed dikes. Moreover, the curving strata of sandstone and shale have in places cleaved apart, and admitted sheets of lava between them. So the mountain is a dome or bubble of sedimentary rocks, with an eruptive core, with a system of radial dikes, and with a system of dikes interleaved with the strata; it is a mountain of uplifted strata, distended and suffused by eruptive rock.

The stratified rocks examined range in age from Carboniferous to Tertiary. Upon the geological map the combined Trias and Jura will cover half the space; the volcanic area will come next in size, and after that the Cretaceous. The excellence of the topographic work will enable a very thorough delineation of their boundaries. Fossils were found in numerous localities, but no large collection was made. Coal of Cretaceous Age was seen in abundance, but no other valuable mineral.

At the request of Major Powell, Captain C. E. Dutton, of the Ordnance Corps, was directed by the Secretary of War to accompany the former to his field of survey, and was engaged in the examination of a large tract consisting of igneous rocks. It lies in Southern Utah, its northern boundary being about 150 miles south of Salt Lake City, extending thence southward about 85 miles, having a breadth of about 60 miles. It consists of a series of long, narrow tables with intervening valleys, and is structurally a repetition of those features described by Major Powell as characteristic of the

whole of Southern Utah and Northern Arizona, and which led him to call it the Plateau Province. The tables are cut from the platforms of the valleys by immense faults, and uplifted 2000 to 5500 feet above the valley plains, presenting nearly vertical walls fringed at their bases by rugged foot-hills. The plateaus are composed of thick beds of igneous rocks, well stratified and nearly horizontal; the foot-hills on the contrary are composed of beds much broken and disturbed, and intermixed with lavas. The southern portions are overlaid by a conglomerate, which commences near the middle of the region with a thickness of at least 2300 feet, and diminishes southward to 700 or 800 feet. It is composed wholly of igneous fragments, often of great size, inclosed in a matrix of sand and clay. In the southern portion it is underlaid by red sandstone and white marl of Tertiary Age, in the middle portion by rocks of the porphyrite class. The northern and higher portion consists of well-stratified rocks, having the mineral characters in some places of trachyte, in others of rhyolite, but with a structural habit, a texture and general mode of occurrence very unusual in these kinds of rock. Lava beds occur abundantly, but so far as observed are restricted to the foot-hills and valleys, and have evidently originated from the vicinity of the great faults. Captain Dutton inclines to the opinion that the stratified tabular masses were metamorphosed *in situ* from sedimentary beds. This inference is founded, first, upon the striking similarity in the structure of the igneous strata to that of the adjoining sedimentaries—a similarity in many cases exact even to small details; second, upon the absence of volcanic structure in the arrangement of the beds, and in their texture; third, upon the abundant occurrence of rocks which, when serially arranged, exhibit many stages of a progressive metamorphosis; also the occurrence of many large masses which can not be classified, except upon the assumption that they are imperfectly metamorphosed sedimentaries; fourth, the admission that they are eruptive renders the general problems of structure obscure, while if they are metamorphic the structure is a problem no longer, but merely a repetition of well-known features occurring every where in the country round about. The metamorphic origin of some porphyries has long been conceded, but the trachytes and rhyolites have always

been considered volcanic. If these latter rocks are also in the present case metamorphic, the fact will be an important addition to volcanology. Captain Dutton is also engaged in the investigation of the micro-structure of the rocks of this region, and has made considerable progress in the preparation of specimens for microscopic examination.

At the beginning of the fiscal year Professor C. A. White, of Bowdoin College, was appointed paleontologist of the Division, and he immediately joined Major Powell's special party, mentioned above. This party visited many points in Northern Utah, a few in Northwestern Colorado, and a few in Southern Wyoming, making a re-examination of the sedimentary beds of that region, and the evidences upon which they had been previously separated into groups. Many localities where fossils had been obtained in previous years were visited, and other localities discovered. The collections made were from the upper portions of the Carboniferous group, through the whole series to near the summit of the Tertiary. The collections are chiefly of invertebrate fossils, and are very full and satisfactory.

Many new species, and also several types hitherto unknown in American strata, have been obtained. Among the latter may be mentioned a species of Unio, of the recent type of *U. clava*, Lam., and two types of Viviparine shells from near the base of the Tertiary, the layers containing them alternating with others containing *Ostrea* and other brackish-water forms. These facts, in connection with others already known, show that much differentiation had taken place in those families respectively very early in the Tertiary period, if not before. It is an interesting fact, also, that while a change from a salt or brackish water condition of the earlier Tertiary deposits to a wholly fresh-water condition took place without producing any perceptible physical change in the character of the strata, the species, mostly molluscan, were more numerous, and the differentiation of types much greater during the prevalence of salt in the water than at any subsequent time after the waters became wholly fresh. His notes also show that in all the purely fresh-water strata of all the Tertiary groups the species and genera are few, and there is a remarkable uniformity of type throughout. Both branchiferous and pulmonate mollusks range through all the Tertiary strata,

except that they have thus far found none of the latter associated with brackish-water forms. Geophila were obtained from the Green River and Bridger Groups only. These comprise three or four genera of *Helicedæ*.

The Green River Group has furnished several species of insects.

Of vertebrate remains, some massive fragments of bones of a very large saurian, found in Jurassic strata five miles west of Vermilion Cañon, are worthy of remark. Scales and detached bones of teliost fishes were found in considerable abundance in dark shales at the very base of the Cretaceous group at Vermilion Cañon, and also at various other points on the same horizon. Teliost fish remains, mostly very perfect, were obtained from the Green River Group, and also some from other Tertiary strata. Throughout the whole Tertiary series more or less vertebrate remains have been found; but it is the Bridger Group that has furnished the greatest profusion of mammalian, besides many reptilian and a few ganoid remains.

Part of a skeleton of a Passerine bird has been obtained from the Green River Group.

Large collections of plants have been made at numerous localities. Besides samples of silicified exogenous wood from numerous horizons throughout the Mesozoic and Tertiary series, leaves, fruits, etc., have been collected from the upper Cretaceous and Tertiary strata. These are mostly exogens, but both ferns and palms were found associated with them in the upper Green River Group at Alkali Stage Station, twenty miles northward from Green River City.

Ethnography.—Professor Thompson's party discovered the ruins of many prehistoric dwellings similar to those found in former years, and their position will be indicated on the ethnographic map. He also discovered on the cañon walls and rock escarpments of the country many Shi-nu-mo etchings, which were copied to scale. They will make a valuable addition to the collection of former years.

While on his travels Major Powell met with certain tribes of Shoshoni Indians, whose arts were unrepresented in the National Museum, and the opportunity was seized upon to make collections of their implements, clothing, etc. In all departments, except that of food-plants, these Indians are

now so fully represented as the Utes or Pai-Utes by his former collections. Some additions were made to his Shoshoni vocabularies and to his mythological tales.

Botany.—Mr. L. F. Ward was attached to the Division as botanist, and made a very large collection from a region but hitherto little studied. He also collected a large suite of wood sections of the various shrubs and trees found in the region.

Photographs.—Mr. J. K. Hillers, the photographer, made 101 negatives for topographic and geological purposes, and 10 for ethnographic.

Altogether, Major Powell considers that the result of the year's labor has been more satisfactory than that of any previous year.

EXPLORATIONS AND SURVEYS UNDER LIEUTENANT GEORGE M. WHEELER, U. S. ARMY, IN 1875.

Field parties were organized in the latter part of May for duty during those months when operations can be carried on in the higher altitudes of Colorado, New Mexico, California, Nevada, and Arizona. The office-work, as usual, continued in Washington.

The expedition of the year was made co-existent in three several sections: 1, California Section, starting from Los Angeles as an initial point; 2, Colorado Section, from Pueblo, Colorado; and, 3, the section on work being regularly carried on at the office in Washington.

The parties sent out from Pueblo disbanded at West Las Animas, near Fort Lyon, on the Arkansas, about November 20th; and those dispatched from Los Angeles, California, rendezvoused at the close of the season at Caliente, California, the present terminus of the Southern Pacific Railroad, with the exception of the party under Lieutenant Bergland, engaged in temporary office duties at Los Angeles, after the return of its members from their duties in the valley of the Colorado River, or rather that portion thereof lying to the southward of the great bend of this stream.

The California Section consisted of three main parties, the first under the command of the officer in charge, Lieutenant Wheeler; another, destined for the Death Valley region, under Lieutenant Rogers Birnie, Jr., 13th U. S. Infantry;

and the third in charge of Lieutenant C. W. Whipple, Ordnance Corps, U. S. A. A separate party, under Lieutenant Eric Bergland, Corps of Engineers, was engaged upon the banks of the Colorado River, with the special end in view of determining whether within certain limits of the Grand Cañon of the Colorado this stream could be diverted from its present channel, with a view to utilizing its waters in a system or systems of irrigation.

The reports received to date, although not final, confirm the idea that within the line of this portion of its flow—namely, from a point at the foot of the Grand Cañon to the Needles, below Camp Mojare—no practicable points were discovered at which the river could be taken from its present bed *with utility* for irrigating the comparatively desert wastes on either hand, or any of the valleys known to be of an arable character. Further examinations will be prosecuted during the winter in the valley of the Lower Colorado, with a view to determining as to the practicability of points in this portion of the river at which its waters might be diverted, and with what practical results; and also as to whether a series of lakes might or might not be used as links in the chain of communication that would be formed should this great stream be transferred from its present cañon bed to one of an alluvial character. Taking into account the ratio of evaporation from surfaces of water in these arid regions, the maximum size of the lake surfaces necessary to retain all the waters of this stream in reservoir might be determined, and the comparison of this aggregate area to that of the areas of depression found to exist along a line of transit, should such new channel be formed, can be ascertained.

A special party, acting in co-operation with one dispatched by the Smithsonian Institution under the charge of Mr. Schumaker, was placed temporarily in charge of Dr. H. C. Yarrow, of the Survey, for the purpose of making collections in ethnology upon the southwest coast of California, near Santa Barbara. The party from the Smithsonian Institution have carried on their labors upon the island southwest and adjacent to the coast at this point. The results of their labors already transmitted to Washington show that they were well bestowed; and without doubt the collections, when

thoroughly worked up and reported upon, as they soon will be by Professor F. W. Putnam, curator of the Peabody Museum of Archæology of Harvard College, will show much information of value in determining the antecedents and presumable actual condition of the aboriginal tribes inhabiting this quarter at the time of interment of the individual bodies and specimens, and possibly their connection or want of connection with the present aboriginal races.

The Colorado Section was composed of three main parties, commanded respectively by Lieutenant W. L. Marshall, Corps of Engineers, Lieutenant W. L. Carpenter, 9th Infantry, and Lieutenant C. C. Morrison, 6th Cavalry. Their field duties covered parts of Southern and Southwestern Colorado, Central and Western New Mexico, from the Rio Pecos to the western boundary of this territory. The character of the geographical work has been advanced to such a degree that a complete geodetic connection is made to all parts of the area covered, each being taken from the crests of the several conspicuous mountain ranges that exist in this portion of the United States territory; the main triangulation being connected with measured and developed bases at the main astronomical points determined by parties of the survey in advance. Professor Jules Marcou, a veteran in geology, was a member of one of the parties of the California Section, and visited fields novel to him in the year 1854, when a member of Lieutenant Whipple's Pacific Railroad Survey party along the thirty-fifth parallel, bringing to his service the accumulated experience of geological investigations made by himself and others extending over an interval of nearly twenty-five years.

The subjects of Geology, Paleontology, and other branches of Natural History were made part of the season's work, as usual; and the advance therein, as well as in others, will appear in the regular reports submitted to the government from time to time. Dr. Oscar Loew, a member of the expedition for the third year, was engaged with the party upon the Colorado River in prosecuting, as usual, studies in geology and mineralogy; and it is hoped that the analyses to be made by him of the waters of the Colorado River, and of various soils and mineral substances, will add no little scope to the results of the season. The usual number of

topographers, meteorological observers, etc., have been attached to the several parties.

The fact that this Survey is so far advanced in the improvement of its methods, and in the use of instruments specially fitted for mountain geodetic work, should appear as a gratification to all, since each and every person is or ought to be interested in the acquisition of exact geographical information; and that the government shall from time to time in so satisfactory a manner advance to a state of perfection the geographical works inaugurated under its charge, is evidence in the direction of the establishment of a great survey or surveys similar in plan, method, and execution, and perhaps more complete and original in many of their details than those so long prosecuted with so much profit and satisfaction by the great governments abroad.

One of the parties engaged in the Southern Sierras about the heads of King's and Kern Rivers were fortunate in ascending probably the highest measured altitude within the boundary of the United States, and determining its exact latitude, longitude, and altitude. This peak, known as Fisherman's Peak, had been ascended in 1872 by a party engaged in the pleasure of trout-fishing upon Kern River, and was by them discovered to be at least three hundred feet higher than any of the other prominent peaks, one of which had been named Mount Whitney by Clarence King, of the 40th parallel survey, and it is now determined to be approximately 14,800 feet in height. This peak was also ascended, subsequent to its being named Fisherman's Peak, by Mr. Clarence King, and his determination as to altitude, when made, should be a check upon the determination by parties of this season. A full description of this great monument of nature, something most difficult to be made, will be an individual evidence of one of the many discoveries made by the parties of this season.

Bases were measured at Los Angeles and Caliente, California. At the former place connection was made with the base of the United States Coast Survey, measured by the then Captain, now Brevet Major-general E. O. C. Ord, U. S. Army, and practically a connection was had with the geodetic stations of the United States Coast Survey, between latitudes approximately 34° and 35° north, and a complete sys-

tem of triangles was carried eastward as far as approximately to the 120th meridian of longitude, in a three-tier belt.

Although the appropriation made by the last Congress was exceedingly meagre, still, principally through the assistance of the Quartermaster's Department, the greater percentage of the regular force was kept in the field, so the government was enabled still to avail itself of the skilled persons engaged in this work.

The publications of the Survey now advancing to completion consist of six quarto volumes; and two atlases—one topographical and one geological—are being rapidly advanced. Two volumes—those on geology and zoology—will be presented in January, 1876, and two others are in press, while the remaining two are being pushed with vigor. The sheets of the topographical atlas, now nearly completed, are twenty-four. Those of the geological atlas will number fourteen.

Lieutenant Wheeler, in his report submitted to the Chief of Engineers for the present year, recommends an additional volume upon the subject of Ethnology, Philology, and Ruins, based upon examinations made upon these subjects during several years, to be published as soon as provision is made therefor by Congress.

FRITSCHE'S TRAVELS IN CHINA.

Fritsche, who, since leaving the imperial observatory at Pulkova in 1866, has been very actively engaged in geographical, magnetic, and meteorological work, as director of the Russian observatory at Pekin, China, has recently published the results of observations during an extensive journey in Mongolia, Siberia, and Russia, undertaken in the summer and fall of 1873. His travels in Mongolia and Northern China carried him through countries as yet almost entirely unknown, the most important journey in this region having been that of the Archimandrite Palladius. This portion of Fritsche's exploration was performed by him on foot and horseback, although he states that his subsequent experience assured him that he could have made it, with safety to his instruments, in the Chinese two-wheeled wagon. The most important town on his route is Siwantsee, a large Chinese city, where is founded the central Belgian Catholic

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mission. The city is outside of—that is, north of—the great Chinese wall, and the missionary establishment is on the most extensive scale, with a fine church, and a school formed of poor Chinese children. The Christians living there, however, are not Mongolians, but the descendants of Christian Chinese who emigrated from China in order to escape the persecution of the Chinese authorities.

The contributions of Fritsche to the correct geography and hypsometry of the country traversed are numerous and reliable. One of the most interesting series of observations made by him consists in a large number of determinations of positions and altitudes of peaks belonging to a range of mountains which appears upon one or two old charts under the name of Petseha, but is not generally given upon our maps. The height of the principal peak seems to be about 1500 meters, instead of 14,000 feet, as was reported by the Archimandrite Palladius as having been given him by the Chinese authorities. No snow-clad mountains are known in the entire region. At two stations—Siwantsee and Chuschay—he was able to secure missionary observers, and promises from them of continuous meteorological observations. Magnetic observations were made by Fritsche throughout his entire expedition with a new and excellent instrument constructed by Brauer, according to the plan of Wild; and these afford him the basis for a short chapter on the secular variation of the declination, inclination, and intensity, as shown from the observations that have been made in China and Siberia since the journeys by Humboldt. The results in general confirm those given by him in an earlier work published some five years ago. The annual change in the magnetic intensity appears to have remained nearly constant in Western Siberia, but to have doubled in China and Eastern Siberia.

MAJOR POWELL'S FINAL REPORT.

In the summer of 1867 Professor J. W. Powell, of Bloomington, Illinois, undertook to make an examination of the fossil-bone region of the Bad Lands of the Niobrara and White River, north of the Platte, but, owing to threatened hostilities on the part of the Indians, the military authorities declined to permit him to run the risk of entering their

country. He accordingly turned his attention to Colorado, and made some explorations in the direction of Grand River. In 1868 he again took the field, and proceeded first to the Middle Park, and thence down the Grand River to the head of Cedar Cañon, then across the Park Range by Gore's Pass, and by October was encamped on the White River, about one hundred and twenty miles above its mouth. Here he built cabins and established winter-quarters, and devoted the winter season of 1868–69 to excursions southward to the Grand, down the White to the Green River, northward to the Yampa, and around the Uinta Mountains.

Every season since then the Professor has been engaged in continuing his work, until what was commenced simply as an incidental summer's trip became an elaborate survey of the geography, geology, ethnography, and natural history of a vast extent of territory.

At the outset of his enterprise Professor Powell carried on his work without any aid from the general government beyond some facilities in the way of obtaining army rations. Subsequently, however, appropriations were made by Congress to a limited extent, and his survey was placed first under the War Department, then under that of the Interior, then under the Smithsonian Institution, and finally back again under the Interior Department, to which branch of the service it now belongs.

As in other government expeditions of later date, all branches of research have been well attended to. In the later years Professor Powell's labors have been carried on with the utmost precision, a base-line having been correctly measured, and a regular trigonometrical survey conducted. A large part of the cañon region of Colorado has been already mapped out by him, and its remarkable features well illustrated.

We have now to chronicle the appearance from the government press of the first volume of the final report of Professor Powell in the form of a handsomely printed quarto, with numerous illustrations. This volume is composed of three parts. First, the history of the exploration of the cañons of the Colorado, from Green River City to the cañon of Lodore, and from Echo Park to the mouth of the Little Colorado and the Grand Cañon of Colorado, with a special

report by Professor Thompson, the topographer, who has been the companion and associate of Professor Powell during most of the period of the survey. The second part is upon the physical features of the valley of the Colorado. The third part, upon the zoology, consists of papers upon the genera *Geomys* and *Thomomys*—forms of rodent mammals very abundant in the region explored—and prepared by Dr. Elliott Coues.

The illustrations of the volume consist of two maps and eighty wood-cuts, of which about thirty represent geological sections, and about fifty landscape and other views. These latter are especially interesting from having been well engraved by H. H. Nichols, of Washington, from stereoscopic negatives printed directly on the wood, thus guaranteeing their fidelity, and proving that to be practicable which has been generally considered impossible.

REPORTS OF THE NORTHERN BOUNDARY SURVEYS.

It will be remembered that several years ago an international commission was appointed to mark the boundary between the United States and British America, from the Lake of the Woods to the summit of the Rocky Mountains, along the forty-ninth parallel of latitude. This survey from the east was made to meet the point at which the line started in 1857 from the Pacific Ocean had stopped in 1860. The superintendence of the second branch of the American line of the survey, as that of the first, was intrusted to Mr. Archibald Campbell, of Washington, with Major Twining, of the United States Engineers, as astronomer and surveyor, and Dr. Elliott Coues as geologist and naturalist, and the line was finished in 1874. Since then the American party has been engaged in preparing its report for publication.

The British branch of the survey has been not less industriously occupied, and has, indeed, anticipated its American colleagues in commencing the publication of the report, of which the first part—that on geology and the resources of the region of the forty-ninth parallel, by George M. Dawson, Esq.—is before us. Mr. Dawson is a son of the well-known Principal Dawson, of M'Gill College, Montreal, and inherits his father's tastes in the line of geology and paleontology.

The report, which is addressed to Major D. R. Cameron,

the British commissioner, is quite comprehensive, and refers to the physical geography and general geology of the whole country, and the special geological structure of particular portions of it. The economical geology, which is represented mainly by the iron deposits and the coal, receives special attention. A considerable portion of the volume is devoted to the study of the glacial period and superficial deposits, as also to the capabilities of the region with reference to settlement. In the appendix is a list of fossil vertebrates and plants, the butterflies and orthoptera, the land and fresh-water mollusks, and the recent plants.

We hope soon to be able to chronicle the appearance of the American report, which it is understood will be fully equal in extent and thoroughness of execution to those of similar character recently published by the War and Interior departments.

THE SOURCE OF THE HUDSON.

Among the waters located on the new maps of Mr. Verplanck Colvin's Topographical Survey of the Adirondacks appears the little lake "Tear of the Clouds." In such a lake region as this, where every stream which does not flow directly from a pond, if further traced toward its origin, finally dwindles to a mere run without definite commencement, the last or uppermost pond upon it is generally accepted as the head and fountain of the river or stream. Were we to seek for any higher source than this, we must ascend from the rills, through the rain-drops, up to the clouds. If we take the highest permanent body of water of the river's source, we shall find the head of the Hudson in this little lakelet, "The Tear of the Clouds," or "Summit Water," high up on the side of Mount Marcy. The entire Adirondack region contributes more or less directly to the flow of the Hudson, and the opinion maintained by Mr. Colvin is quite plausible, viz., that a century hence, when the entire course of this river shall be occupied with villages and cities, it will be necessary to construct an aqueduct from the Adirondacks to New York, in order to supply that city and the interior towns with a continuous and generous supply of water whose purity can be relied on. It therefore seems important that even at the present time measures be taken to

prevent the destruction of forests in this region, which may be accomplished by the state itself becoming proprietor of the greater portion of the territory, and setting it apart as a public park—as a summer reserve, in fact, for the feeding of the canal system of New York. We might then witness the astonishing spectacle of a wilderness agriculturally worthless becoming the arbiter of empire, and by its wonderful hydraulic facilities and fortunate location giving to the State of New York, to a considerable extent, the control of the commercial destinies of the great West, the Canadas, and New England.—*Colvin's Survey of the Adirondacks.*

CORRECTION OF LEVELS.

The officers of the Army Signal-office, as also of our public surveys, have daily need of accurate determinations of the altitudes of points in the interior of the country. To this end both the Coast Survey and the Smithsonian Institution have for many years been collecting the statistics of levelings made by railroad engineers, and all of these collections have been quadrupled in extent by the labors of the Army Signal-office. In addition to the extensive examinations given to this mass of material by the Weather Bureau, Mr. Gardner, the geographer to the Geological Survey of the Territories, under the Department of the Interior, has made an exhaustive analysis of the altitudes along certain lines of railroad, all leading to Denver, Colorado, his object being to determine the elevation of that point by as many independent lines of level as possible. In the course of his work very many illustrations show the great accuracy that can be attained by careful study, with good engineering instruments. He states, in effect, that of the innumerable discordances that occur, by far the greater portion are traced to errors of calculation, and not to instrumental defects or errors of observation. He establishes with great apparent probability some important changes in the accepted levels of points in this country. Thus the great lakes and surrounding country are found to be about nine feet, and St. Louis about twenty-three feet, higher than hitherto accepted. Kansas City and the surrounding country for many hundred miles south and west has heretofore been reported

more than a hundred feet too low. Omaha is raised about thirty-one feet, and Indianapolis about one hundred. The range between the determinations of the elevations of various points is as follows: Lake Ontario, two determinations, a range of 3½ feet; Lake Erie, five determinations, a range of $2\frac{3}{10}$ feet; Lakes Michigan and Huron, nine determinations, a range of 5 feet; St. Louis, five determinations, a range of 7 feet; Omaha, five determinations, a range of 23 feet; Kansas City, four determinations, a range of 10 feet; Denver, three determinations, a range of 6 feet.—*Hayden's Annual Report for* 1873, p. 638.

HYPSOMETRY IN CALIFORNIA.

The use of the barometer in measuring altitudes in the interior of this continent has received excellent aid from the tables and investigations of Mr. Pettee, of Cambridge, Massachusetts, under the charge of Professor Whitney, state geologist of California. The work of Professor Whitney, besides containing an abstract of all the important publications relating to this subject, gives in detail the steps by which he has been able to compile an empirical table which, he says, may be used with advantage for California, and possibly for the whole of the Rocky Mountain region. The first requisite in the investigation being the accumulation of trustworthy observations, Professor Whitney found it necessary to establish stations in care of the telegraph operators on the line of the Central Pacific Railroad, supplying them with all auxiliary apparatus. These stations were maintained for three years, although with considerable breaks in the continuity of their record. The elevation of the highest point was seven thousand feet above the sea, and that of the lowest point only twenty or thirty. Among the conclusions that Professor Whitney draws from his observations, we mention that the resulting altitudes are always lower as computed from morning and night observations than at mid-day. They are also lower in winter than in summer, when the lines are based upon the mean of all the observations of any day. The results are found at some stations to approximate most closely to the truth in February, September, and October; at other stations in March, April, and September. The 7 A.M. and 9 P.M. observations

give results which agree, in the main, with each other. In making use of the tables given by Professor Whitney, the most that can be hoped for is a better agreement among themselves of the altitudes computed from observations taken in different conditions of the atmosphere.—*Whitney's Contributions to Barometric Hypsometry*, p. 42.

THE STADIOMETER.

The stadiometer is the name given by Captain Bellomayer to an instrument invented by him, which is intended to give by one simple reading the length of any line whatever—straight, broken, or curved—as drawn on charts and plans executed on all kinds of scales. The principle of its construction is quite simple. A toothed steel wheel rolling along over the given line makes an endless screw move by means of a pinion. Upon the screw a slider, held in place by friction, is then forced to rise or fall. The graduations are marked upon two faces of the instrument, on the right and left of the slider. The instrument carries eight scales, corresponding to the scales of the French, Prussian, Belgian, Italian, and other national charts, together with the scale corresponding to the natural scale of our meter. Other scales which are less frequently used may be derived from those which are engraved on the instrument. In using the instrument it is held at right angles to the chart, the toothed wheel pressing against the surface of the latter. As the wheel is rolled along over a given line, the slider is, by means of the endless screw, pushed along the graduated scale of the instrument, and the quantity of its movement as shown thereon gives the exact line to be measured on the chart. The principle of the stadiometer has been for a long time known and used. For many years the French Dépôt of Charts and Plans has been accustomed to pay its engravers according to the total length of the curved lines which they trace, measuring these lengths by means of wheels rolling along over the lines; but the instrument devised by Captain Bellomayer replaces these elementary devices by a very portable, convenient, and precise instrument.—13 *B*, III., 203.

G. GENERAL NATURAL HISTORY AND ZOOLOGY.

ORIGIN OF ANIMAL FORMS.

Professor Cope in an essay published by the Hayden United States Geological Survey, dated February, 1874, discusses the origin of the great population of animal forms which previous explorations had disclosed in the lake deposits of Wyoming. His conclusion was that they had been derived by migration from the South, as geological investigations pointed to the earlier elevation of the land in that direction. During the summer of 1874, Professor Cope, as paleontologist of the United States Survey under Lieutenant Wheeler, sought for and discovered in New Mexico a great mass of lacustrine deposits, of somewhat earlier age than those of Wyoming, and containing the remains of a great number of animal species and genera, which so nearly resemble those of Wyoming as to leave no doubt that the latter were derived by descent and migration from New Mexico and the South.

In a memoir read before the Academy of Natural Sciences of Philadelphia at nearly the same time, the same writer states that the primitive type of the mammals with convoluted brains "must have been bunodonts with pentadactyle plantigrade feet;" that is, must have had tubercle-bearing grinders and five-toed feet, whose entire soles were applied to the ground in walking, and not merely the toes, as in most living animals. It was also stated that variations in the number and relations of the front teeth might be expected in such a hypothetical group of animals, which was named *Bunotheriidæ*. During the explorations in New Mexico the following season a remarkable genus was discovered, and afterward named *Calamodon*. Its jaws and teeth were obtained, and the latter had tubercle-bearing crowns. Subsequently Professor Marsh described more perfect specimens, which show that this animal was also five-toed (pentadactyle), and walked on its soles (plantigrade). With other similar genera he forms an order *Tillodontia*, and says that they are related to hoofed animals (*Ungulata*) and *Carnivora*, and

that their brains were somewhat convoluted. This is a very full confirmation of the anticipation by inference above mentioned. It was then stated that the primitive Ungulate "can not be far removed from the primitive Carnivore and the primitive Quadrumane." Two other genera discovered by Professor Cope show that great variations in the number of the front teeth exist in these animals, some having one, and some two pairs of incisors, etc.

THE CELL-STRUCTURE OF ORGANIC TISSUES.

Professor Redfern, at the late meeting of the British Association, called attention to the changes that have taken place in the views of scientific men in regard to the cell-structure of organic tissues since the days of Schleiden and Schwann. At that time the separation of groups of cells by a basement membrane was considered to be an important physiological condition; such groups, retaining individuality, carry on their life, and even pass into such diseased conditions as cancer, without influencing or being influenced by neighboring structures. Now all is changed, and the idea of a cell as a vesicle has given place to that of a solid corpuscle. Graham has taught that all the tissues are permeable, and continually permeated by fluids carrying nutrient material; and we more lately learn that the living corpuscles can wander out of their positions of attachment, enter the blood current, and again pass from the blood-vessel through its soft and viscid wall. There indeed seems to be evidence that the finest filaments of nerves end in the living corpuscles or cells, especially in the olfactory and gustatory cells, and the skins of fishes. According to Professor Redfern, the statement of Pflüger that the nerves terminate in the cells of the salivary and pancreatic glands, although probable, has not yet been positively established.—15 *A*, *August* 29, 1874, 279.

RAPID DEVELOPMENT OF INTRODUCED ANIMALS AND PLANTS.

It is well known that certain plants, when grown in new countries, exhibit a remarkable development vastly exceeding that which takes place in their native soil. This is evidenced in the character of eastern vegetables when grown in California, of which such marvelous tales are sometimes related. The same thing appears to exist in a greater or less

extent in the case of animals, especially in fishes, particularly where transported to countries in which that particular group was originally wanting.

Wonderful tales are told of the rapidity of growth of the German carp in California, to the effect that they will become as large in one year as they do in Germany in three or four, and be capable of reproduction in the same period. However this may be, we are assured that the success which has attended the introduction of the English trout into Australia has been quite remarkable. A recent writer states that in November, 1872, about 400 fry were turned out at Ballarat, having been hatched in the month of September previous. In January, 1875, or twenty-six months after being liberated and twenty-nine months after hatching, some of these fish were taken in a net, one of them, a female, weighing an ounce less than 10 pounds; two others turned the scales at $9\frac{3}{4}$ pounds, two at 9 pounds, and four or five others averaged $7\frac{1}{2}$ pounds each; and the smallest fish taken weighed over 6 pounds, and all were in splendid condition.

A somewhat similar experience was had in the case of certain perch, the progenitors of which had been brought the year before from England. Three years previous a soda-water bottle, filled with eggs of perch, was placed in a lagoon at some distance from Ballarat. The fish hatched out, and quite lately several specimens weighing 5 pounds and upward have been taken.—19 *A*, *April* 24, 405.

INFLUENCE OF THE ROOTS OF LIVING VEGETABLES UPON PUTREFACTION.

Jeaunel states that the project for utilizing the waters of the sewers of Paris by allowing them to flow over 2000 hectares of cultivated fields, near Paris, has caused some apprehensions on the part of sanitarians. In reply, one may inquire why the neighboring island of Jennevillius, receiving, as it does, the enormous quantity of 240,000 cubic meters of putrid water, should not be a dangerous centre of infection, and menace the health of the populations of all the neighboring suburbs, and even of Paris, the northwest quarter of which is only two kilometers distant from the irrigated lands. This great question seems answered by experience. The inhabitants of the villages above quoted, the laborers who live upon

the soil fertilized by the sewerage, are not subject to any of the maladies which it is customary to attribute to it, such as typhoid fever, malarial fevers, etc. This immunity doubtless results from the fact that the vegetables cultivated there are themselves powerful agents of purification. But science does not yet show precisely how they bring this about. The fact, however, that cemeteries, bogs, and marshes are made salubrious by vegetation is indisputable, being purely the result of experience. His own theory is that the roots of growing plants have the power of arresting the putrefaction of all organic matters held in suspension or in solution in the water; that these roots of living vegetables are sources of oxygen, since under their influence the bacteria and monads, as well as putrefying and fermenting matters, disappear, and are replaced by the infusoria which live in relatively wholesome water. Experience, in fact, directly confirms common opinion which attributes to vegetables the power of rendering wholesome the soils impregnated with putrefying animal matters.—*Bulletin Hebdomadaire*, XVI., 79.

COLLECTIONS OF FOSSILS FROM THE COAL-MEASURES OF OHIO.

Professor Newberry, director of the geological survey of Ohio, has lately made additional collections in the fossil-bearing coal-measures. Land vertebrate remains of that age within the limits of the United States have as yet been only found in Ohio, and the specimens are noted for their singularity and beauty. Thirty-three species of batrachia have been found, but no reptiles nor higher vertebrata. One of the novelties is a species of the genus *Ceraterpeton*—the first time a European genus of fossil batrachians has been detected in this country. This form is as large as a rat, and has a pair of stout horns on the back of its head, in the position and having much the form of those of the ox. The skull is sculptured by rows of small pits, separated by fine radiating ridges.

LIVING ANIMALS CORRESPONDING TO THOSE OF PREHISTORIC AGES.

The discovery of a living species of ganoid or dipnoan, fish of the triassic period, recently made in Australia, attracted much attention at the time. It is the *Ceratodus forsteri* of

Krefft. No other species was known which would connect the living and extinct ones during the great lapse of time between the mesozoic and existing ages. But recently Mr. Krefft has obtained a new *Ceratodus* from the same cave formations which contain the remains of the great extinct kangaroos and *Diprotodons*, which are late tertiary or post-pliocene. The species is called *C. palmeri*. Thus a beginning is made in tracing the line of succession similar to that recently developed in the case of the North American gar-fishes.

EOZOON, ITS ORGANIC CHARACTER.

The controversy as to the organic character of *Eozoon Canadense* still continues among geologists. It may be remembered that the organic character of this supposed fossil has been stoutly affirmed by Professors Dawson and Carpenter, and denied by Professor King and others. One of the latest sharers in the controversy is Mr. H. J. Carter, an eminent specialist in regard to the lower orders of animal life, and who expresses himself in the strongest terms on the opposite side. Dr. Carpenter, however, comes to the defense of his views by insisting that Mr. Carter has not made himself acquainted, in the slightest degree, with what has been written in support of the organic character of these objects, and that Professor Schultze, an equally eminent specialist, is satisfied that it belongs to the foraminifera.—12 *A, April* 23, 1874, 491.

ANTIQUITY OF THE CAVERNS AND CAVERN LIFE OF THE OHIO VALLEY.

Professor Shaler has published a memoir upon the "Antiquity of the Caverns and Cavern Life of the Ohio Valley," in which he endeavors to show the period at which the animal life, so characteristic of Western caverns, received its first expression. He sums up his researches in the following propositions: 1. The extensive development of caverns in the Ohio Valley is probably a comparatively recent phenomenon, not dating farther back than the latest tertiary period. 2. It is doubtful whether there has been any extensive development of cavern life in this region before these caverns of the subcarboniferous limestone began to be excavated. 3. The

general character of this cavern life points to the conclusion that it has been derived from the present fauna. 4. The glacial period, though it did extend the ice-sheet over this cavern region, must have so profoundly affected the climatal conditions that the external life could not have held its place here in the shape we now find it, but must have been replaced by some arctic assemblage of species. Under the circumstances, it is reasonable to suppose that most if not all the species found in these caves have been introduced since the glacial period. 5. We are also warranted by the facts in supposing that there is a continued infusion of "new blood" from the outer species taking place, some of the forms showing the stages of a continual transition from the outer to the inner form.—*Memoirs, Bost. Nat. Hist. Soc.*

NEW MODE OF EMBALMING.

Madame Jaloureau has lately furnished what l'Abbé Moigno considers an important contribution to the question of the disposal of the bodies of the dead. This process consists essentially in the use of an impermeable coffin, together with certain substances which produce a rapid decomposition—not putrid, however—and which can not escape from its inclosure. The coffin, which is made of tough material, is thoroughly coated inside on all its joints with bitumen or asphalt, and covered on the exterior. The body itself is then brought in contact, prior to being sealed up, with phosphate of lime, which has the property, already referred to, of causing a rapid decomposition, but without any unpleasant odors. It is asserted that by this method coffins opened at the end of five years are absolutely free from any disagreeable smell. It is maintained that by following this process coffins may be piled one above another in limited inclosures, and without the danger of any unpleasant or noisome exhalation, and that interments can be made in vaults and tombs without necessitating the process of embalming.—3 *B*, *April* 1, 1875, 501.

THE INTESTINAL SECRETIONS.

Dr. Brunton has for some time past been prosecuting an inquiry into the intestinal secretion, with the special object of ascertaining, first, whether other neutral salts have a similar effect to that of sulphate of magnesia in promoting this

secretion; second, whether any compound have the power of preventing such action; and, third, what are the nerves which regulate the intestinal secretions during life? In answer to the first, he has ascertained that several neutral salts possess the same power as sulphate of magnesia, but in a less marked degree. In reply to the second, he states that sulphate of atropia has such power over the secretion of the submaxillary glands, but that it has no effect in restraining the full action of magnesia in increasing the intestinal secretion. As to the nerves regulating the secretion, a negative result was obtained, he having ascertained that it was not the splanchnic nerves; what they really are Dr. Brunton hopes to learn in a future inquiry.—15 *A*, *August* 29, 1874, 274.

DISCOVERY OF ANIMAL REMAINS IN THE LIGNITE BEDS OF THE SASKATCHEWAN DISTRICT.

An important contribution to the question of the age of the so-called "transition" or "lignite" beds, which contain such a large proportion of the Rocky Mountain coal, has been made by George M. Dawson, the geologist of the British North American Boundary Commission. He has discovered a locality, rich in fossils, in beds of this age on the Milk River, in the Saskatchewan district. The remains presented include fishes, turtles, and numerous land saurians, but no mammals. The saurians belong to that strange group, the Dinosauria, which are not known to have existed later than the cretaceous period, and their presence determines the lignite beds to be cretaceous in that vicinity, as they have already been proved to be in Dakota, Wyoming, and Colorado. Several of the species are common to most or all of these places. There are also found in the Milk River locality remains of gar-fishes. These have been found also in the tertiary, and are yet living. Thus, although they are an ancient type, they connect the cretaceous and tertiary formations more closely than has been heretofore known.

THE FUNCTIONS OF CERTAIN CANALS IN THE EAR OF MAN AND THE MAMMALIA.

The most important paper in the department of anatomy and physiology presented at the last meeting of the British Association, in 1874, is said to have been that of Professor

Crum-Brown upon the function of the semicircular canals of the internal ear of man and the mammalia. From a critical study of various preparations made of fusible metals and otherwise, he concludes that these canals enable us to perceive rotation around axes at right angles to the plane of the canals. The fluid in the canals is set in motion by the rotation, and caused to impinge upon the delicate hairs in continuity with nerves, contained in the dilated portions of the canals; and according as the rotation is around one axis or another, the fluid of one or another of the three pairs of semicircular canals is set in motion, and we are enabled to estimate the direction of the rotation. A number of ingenious experiments were stated, in which the person to be experimented upon was seated on a rotating table; and precautions being used to exclude the use of other means of perceiving the amount and direction of rotation being called into play, the table was rotated, and the character of the sensorial impressions produced was noted. These varied with the position of the head, and the amount of the rotation, in such a way as to confirm Professor Crum-Brown's hypothesis that the semicircular canals are the organs whereby these motions are estimated.—15 *A*, *September* 5, 1874, 318.

RESTORING THE RED COLOR OF ALCOHOLIC PREPARATIONS.

M. Felix Plateau publishes a notice of a method of preserving or restoring the natural red color to muscular fibre kept in alcohol, in which he remarks that carbolic acid only preserves this red tint for a short time; besides which the odor is very disagreeable, and the preservation is not permanent unless in connection with continued cold.

Plateau's method consists in first soaking the specimen for some days, after being properly dissected, in commercial alcohol diluted with about half the volume of water, and then drying with a rag. Some small cups are to be prepared, containing respectively some carmine, in powder, mixed with a few drops of ammonia, some powdered chromate of lead (chrome yellow), and lampblack. By means of a small camel's-hair brush several layers of the solution of carmine, more or less diluted with ammonia, are applied to the muscles, after which a little chrome yellow or lampblack is to be added, so as to obtain, by this method of painting, the tint approach-

ing as nearly as possible that of fresh muscular fibre. It is better to use but a small quantity of the liquid at one time than to put on several layers. When this is accomplished the entire preparation is immersed from five to ten minutes in a solution of alum, saturated in the cold. It is then rapidly washed in pure water, and finally placed permanently in alcohol.

The theory of the process is very simple, according to Plateau. By dissolving the carmine in ammonia, an ammoniacal solution, or carminic acid, is obtained; and after the painting of the muscle, the addition of alum has the effect of producing a gelatinous, uncolored precipitate of hydrate of ammonia, which is carried away by the excess of the liquid. Consequently, an insoluble carmine lac is formed, which, penetrating a certain depth into the flesh, forms a very solid dye. Specimens in the University of Ghent, prepared as long ago as 1872, still retain all their original beauty. It is not necessary that this process be practiced on fresh muscle. Any preparation, however old, can be restored in this way to the appearance of nature. It is of course optional with the experimenter to apply the color only to such particular muscles, in an anatomical preparation, as it is desired to trace out for demonstration.—*Bull. Roy. Acad. Sci., Belgium*, 1874, 476.

FAUNA OF THE MAMMOTH CAVE.

Interesting additions to our knowledge of the fauna of the Mammoth Cave have recently been made by Mr. F. W. Putnam, of Salem, who, as a special assistant on the Kentucky State Geological Survey, of which Professor N. S. Shaler is the director, had great facilities extended by the proprietors of the cave, and he made a most thorough examination of its fauna, especially in relation to the aquatic animals. Mr. Putnam passed ten days in the cave, and by various contrivances succeeded in obtaining large collections. He was particularly fortunate in catching five specimens of a fish of which only one small individual had heretofore been known, and that was obtained several years ago from a well in Lebanon, Tennessee. This fish, which Mr. Putnam had previously described from the Lebanon specimen under the name of *Chologaster agassizii*, is very different in its habits from the blind fishes

of the cave and other subterranean streams, and is of a dark color. It lives principally on the bottom, and is exceedingly quick in its motions. It belongs to the same family as the two species of blind fishes found in the cave. He also obtained five specimens of four species of fishes that were in every respect identical with those of the Green River, showing that the river fish do at times enter the dark waters of the cave, and when once there apparently thrive as well as the regular inhabitants. A large number of the white blind fishes were also procured from the Mammoth Cave, and from other subterranean streams. In one stream the blind fishes were found in such a position as to show that they could go into daylight if they chose; while the fact of finding the *Chologaster* in the waters of the Mammoth Cave, where all is utter darkness, proves that animals with eyes flourish there, and is another evidence that color is not dependent on light. Mr. Putnam found the same array of facts in regard to the cray-fish of the cave, one species being white and blind, while another species had large black eyes, and was of various shades of a brown color. A number of living specimens of all of the above-mentioned inhabitants of the waters of the cave were successfully brought to Massachusetts after having been kept in daylight for several weeks, showing that all the blind cave animals *do not* die on being exposed to light, as has been stated.

THE AGENCY OF ATMOSPHERIC PRESSURE IN CAUSING THE UNION OF THE JOINTS OF THE HUMAN BODY.

The agency of atmospheric pressure in securing the union of the joints of the body has long been appreciated, although it has been thought that a puncture of the capsule connecting the joints, by thus admitting air, would materially affect this action. Professor Aeby, of Berne, however, has announced, as the result of a large number of experiments, that in the greater number and the most important of the joints of the human body the atmospheric pressure is fully adequate to retain the surfaces of the constituent bones in contact, even after the division of all the soft parts, including the capsule. This statement is true of the shoulder, elbow, and wrist, as well as of the hip, knee, and ankle joints, and the experiment succeeds in nearly every natural position of the joint, so that

the extremity below any particular articulation can be made to swing within its normal limits of flexion, supported by the pressure of the air alone. Thus, as Professor Aeby expresses it, "When it is found that the arm will hang completely disarticulated in the shoulder-joint, the fore-arm in the elbow-joint, or the hand and fingers in their respective joints, no further proof is required that the ordinary teaching with regard to the relation of air-pressure to the joints is entirely erroneous." Dr. F. Schmid has also lately found by experiment that the atmospheric pressure which retains the surfaces of the hip-joint in contact is not only sufficient to support the lower extremity, unaided by muscles or ligaments, but even to carry an additional burden equal to a third part of the weight of the leg.—20 *A*, *May* 15, 1875, 529.

THE PHYSIOLOGICAL ACTION OF LIGHT.

In a memoir on the physiological action of light, by Professors Dewar and M'Kendrick, these authors have especially directed their attention to the effect produced on the retina and optic nerve. Their inquiry divided itself into two parts: first to ascertain the electro-motive force of the retina and the nerve; and, second, to observe whether this were altered in amount by the action of light. They conclude that the action of light is such as to alter the amount of the electromotive force to the extent of from three to seven per cent. of the total amount, so that a strong flash of light, lasting the fraction of a second, produces a marked effect. A lamp held at a distance of four or five feet, and, equally, the light of a small gas flame, after passing through a depth of twelve inches of a solution of salts of copper and potash, also produce sensible effects. When a diffuse light is allowed to fall on the eye of a frog, after the latter has arrived at a tolerably stable condition, the natural electro-motive power is in the first place increased, then diminished. The effects in question are caused by those rays of light that appear to be the least luminous—namely, the yellow and the green.—1 *A*, XXIX., 258.

ACID OF THE GASTRIC JUICE.

Dr. Roberteau has lately ascertained that the acidity of the gastric juice is due to hydrochloric acid, and not to lactic

acid. This question has been the subject of much discussion between rival experimenters. According to Professor Wurtz, when lactic acid is met with in the stomach it is the result of an impaired digestion.—2 *A*, *February* 26, 1875, 154.

RESEARCHES ON THE SECRETION OF HONEY.

Dr. Reichenau has been engaged in an inquiry as to whether honey and other industrial products of the bees are obtained directly from the food of the insects, or are products elaborated by the organism. He has not completed his research; but as of three albuminoid, nitrogenous substances found in the honey, one, coagulable by heat, does not occur in the juice of the flowers, he infers that it is a true secretion by the bee, which becomes mixed with the nectar. Honey is, therefore, strictly a nitrogenous body, and not simply a carbo-hydrate. In purified beeswax nitrogen was found to the extent of 0.597 per cent.—15 *A*, *February* 6, 1875, 196.

ELECTRIC CURRENTS AND THE FERTILIZED EGGS OF FROGS.

M. Onimus, in a communication to the Biological Society of Paris, has made known the results of experiments on the effect of the opposite poles of the electric current in the germination of the fertilized eggs of the frog, from which it appears that those which were placed on the side of the negative pole are developed more speedily than those by the side of the positive pole. He also found that, by the use of electrodes other than platinum, metallic salts were deposited in the eggs.

LEUCITHINE AND CEREBRINE.

Gobley has published an account of a renewed examination of two bodies named leucithine and cerebrine, found together in the yolk of egg and in brain substance, leucithine being subsequently detected in human venous blood, eggs, milt of carp, and in milk. It appears that the substance obtained by Liebreich, of Berlin, in brain matter, containing phosphorus and nitrogen, and to which he gave the name of protagon, is really composed of these two substances; while the organic base found by treatment of this brain matter, and called by him neurine, is simply the product of the decomposition of leucithine, which when separated is a homo-

geneous, translucent, soft substance. When heated it swells, and, if the temperature be high enough, gives off ammoniacal vapors. It is insoluble in water, but dissolves in æther, chloroform, carbon-sulphide, and benzine. Cerebrine exists in brain matter, from which it is extracted by boiling alcohol. It is treated with æther to remove the fatty matter, and purified from leucithine and lime-phosphate by repeated solution in boiling alcohol. It is a solid, inodorous, colorless body, and is but little affected by æther.—21 *A*, *September*, 1874, 907.

GASES IN THE COAGULATION OF THE BLOOD.

As the result of some recent investigations by Messrs. Matthieu and Urbain upon the part which the gases play in the coagulation of blood, these gentlemen announce that carbonic acid is the agent of spontaneous coagulation; and that, during life, the obstacle to this coagulation resides in the blood corpuscles, which have as their special function the fixation not only of the oxygen, but also of the carbonic acid in the blood. As a result, the coagulating action of this gas can not be exerted in physiological conditions. The blood which returns from glandular organs, especially from the kidneys, is incoagulable, and contains very little carbonic acid. If the removal of carbonic acid from the blood be favored by simple exosmose, coagulation will not take place; yet, if it be placed in an atmosphere of carbonic acid, coagulation rapidly sets in. The clots, however, are softer than those which form in air, rendering it probable that oxygen influences their consistence. Lastly, certain neutral salts impede or prevent coagulation, but such salts fix a notable volume of carbonic acid, and thus withdraw it from the blood.—15 *A*, *October* 21, 1874, 491.

WIND PRESSURES IN THE HUMAN CHEST.

The new Physical Society of London seems to have extended its attention to the dynamics of physiological phenomena, Dr. Stone having recently read a paper before it on wind pressures in the human chest during performance on wind instruments. The author's object was to ascertain, first, what was the extreme height of a column of water which could be supported by the muscular act of expiration transmitted by the lips. This was found to be about six

feet. Second, what was the actual pressure corresponding to the full production of a note on each of the principal wind instruments. It was found that with the majority of instruments the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure ratio of its own. The clarionet is an exception to the rule.

THE DIAMETER OF THE RED GLOBULES OF BLOOD.

It has frequently been maintained by Dr. Woodward and others of the best microscopists that in general the microscope alone does not enable one to decide, by means of the dimensions of the red globules in blood, whether a blood stain belongs to the human subject or to some other of the mammalia. Additional light has been thrown upon this subject by the recent researches by Bershon and Perrier. They find that the red globules in the adult, when fresh, have a normal diameter of 0.0088 millimeter. In dried-up stains, however, the dimensions are as small as 0.0070 millimeter. In the new-born babe many globules are found as small as 0.0030, while many others, on the other hand, surpass the normal limit, and are as much as 0.0090. Thus out of 120 globules taken at chance from three subjects the dimensions were as follows:

	Millimeter.		Millimeter.
2 globules	0.0031	4 globules	0.0068
2 "	0.0043	14 "	0.0075
17 "	0.0050	5 "	0.0081
11 "	0.0056	19 "	0.0087
32 "	0.0062	2 "	0.0091
6 "	0.0065	5 "	0.0093

We see from this the absurdity of pretending that in any case whatever of chemico-legal research the microscopist should pretend to decide as to the character of the blood-stains.—*Bulletin Hebdomadaire*, XVI., 44.

THE GASES OF THE BLOOD.

In a paper by Matthieu and Urbain upon the gases of the blood, it is stated that repeated bloodlettings in dogs caused an increased diminution of the percentage of oxygen contained in the arterial blood, and exercised but little influence upon the nitrogen and the carbonic acid. In the course of

these experiments they ascertained that there was one half per cent. of hydrogen in venous blood, but none in arterial. Outside heat was found to have a great influence upon the oxygen of the arterial blood, its amount being much diminished after exposure to a high external temperature, although the number of respirations per minute is raised thereby. It would seem that increasing temperature decreases the endosmotic interchange of gases through the pulmonary mucous membrane, which has a greater influence in determining the amount of oxygen in arterial blood than the opposing fact of increased respiration. The lowering of the temperature was accompanied by an augmentation of carbonic acid. The amount of oxygen was dependent upon the activity of respiration, the increase of bodily temperature being at first followed by a decrease, and soon after it an increase of carbonic acid in the venous blood. Oxygenation takes place in the capillaries, and not in the larger vessels.

In death from cold there is a decrease in the consumption of oxygen, and but little difference in the composition of the arterial and venous blood. In death from heat there is, however, an enormous consumption of oxygen, and eventually the venous blood contains but little of the gas. The muscles become very acid, which was the cause of their speedy and pronounced post-mortem rigidity.—21 *A*, *August* 21, 1874, 809.

THE PIGMENT SCALES OF THE BLOOD.

Dr. J. G. Richardson makes an interesting suggestion as to the origin and nature of the so-called "pigment scales or flakes" of the blood. He says: "I call attention to an egregious error, by which several microscopists of acknowledged ability have been ensnared, namely, a belief in the importance of the 'pigment cells' or 'scales' described by Frerichs, of Berlin, as occurring in the blood; of similar bodies found by Drs. Meigs and Pepper, of this city, under like circumstances; and of the pigmentary particles, or celluloids, figured by Dr. William Roberts, of Manchester, England—all of which I assert to be simply and solely *accumulations of dirt* (especially the remains of red blood corpuscles) in the little excavations or slides in ordinary use."

Dr. Roberts observes: "I have been in the habit of ob-

serving these objects for many years, and have regarded them as derivations of hæmation; but how they come to assume their peculiar forms I am at a loss to conjecture." Dr. Richardson adds to this: "With him, I believe them to be derivatives of hæmation, but only by the *rubbing process* detailed above; and I trust that my 'conjecture' how these hæmative flakes 'come to assume their peculiar forms' may be satisfactory."

NEW SUBSTANCE IN URINE.

Messrs. Musculus and Mering announce that they have discovered a new substance in urine, after taking hydrate of chloral. This body, to which they give the name of urochloralic acid, is in the form of isolated, star-shaped crystals, soluble in alcohol, but almost insoluble in pure ether. The discoverers class this acid among the substances which, being introduced into the organism, combine chemically with some product of the system, and thus pass into the urine. Benzoic acid is the type of the group, which, in combining with glycocol, is eliminated in the form of hippuric acid.—12 *B, May* 15, 420.

IS SEX DISTINGUISHABLE IN EGG-SHELLS?

It has ever been a desideratum with country housewives and dealers in poultry to distinguish the sex which may result from given eggs, and to apportion accordingly in the nest. M. Genin has lately made a communication to the French Academy of Sciences, in which he claims ability to always separate them, and to have verified his hypothesis by the experience of several years. The eggs containing the germs of males, he says, have wrinkles at their smaller ends, while those containing females are smooth at the ends. We simply give this for what it is worth, and with a caution not to place implicit confidence in it. Indeed, the probability from analogy is against the claim. It will, however, do no harm to bear it in mind, and it will be worth while to make observations to verify or disprove it. The difficulty will consist in following up the egg through hatching out, and until the determination of the sex can be obtained. M. Genin does not tell us how to do this. The observations might be continued by any person in this way: The hatching of the

wrinkled egg should be watched for at term time, and on liberation (which might be assisted by the experimenter) marked, for example, by the excision of the claws or tips of one of the toes (varying the toe cut with the individual), while those from smooth eggs could be allowed to remain unmutilated. If the coincidence between the character of the egg and the sex of the bird should then be confirmed invariably, as alleged, in say a hundred cases, the demonstration of the truth of the hypothesis would be complete, and entirely removed from the chance of irrelative or accidental coincidence. The egg cases should be kept for future reference and observation.

MENTAL ABILITY OF DIFFERENT RACES.

As the result of a laborious experimental investigation into the intellectual capacity and development of children of different races inhabiting the island of Jamaica, Mr. Houzeau concludes, first, that there is in each child a different degree of intellectual proficiency, though these individual differences are much less than might be anticipated; second, that an unequal rate or speed of improvement does not belong especially to any race; third, that the rate of improvement is due almost entirely to home influence, namely, to the relative elevation of the parental circle in which the children live. On the other hand, Mr. Lindsay concludes, as the result of his observations, that at or up to a certain age girls are as quick as, or quicker than, boys, at learning or repeating lessons, but that female superiority, so far as it exists, is usually confined to school life; second, that up to a certain point there is the closest parallelism between the mental endowments of the human child and sundry other animals; in some cases, even, the comparison is in favor of the animals; and yet that we have no reason for supposing that any of these will, at the best, ever attain to even the average of the intellectual and moral development of man.—12 *A*, X., 272.

ON THE EVAPORATION FROM THE HUMAN SKIN.

In order to determine how far the exterior circumstances, as temperature, moisture, the wind, etc., affect the quantity of water that passes from the human system in the form of perspiration, an investigation has been made by Erismann, under

the superintendence of Voigt. By means of apparatus of his own construction he has been able to measure the amount of perspiration in different portions of the human body. He finds that the most important element in reference to the atmosphere is its relative humidity, an increase in the relative humidity corresponding to a decided diminution in the quantity of perspiration. Of less importance is the influence of the temperature. An increase of temperature acts not so much directly by increasing the capacity of the air for moisture as it does indirectly by first of all bringing about some changes in the skin, increasing the supply of water at the surface whence the evaporation takes place. The ventilation, or the wind, has also a very decided influence, the increase in ventilation corresponding to an increase in evaporation. There is considerable interest in his experiments on the influence of clothing upon perspiration, as showing that the clothed arm is subject to variations in the amount of perspiration, which are dependent upon the exterior influences of the air, as is the case with the naked arm. Clothing, in fact, does not diminish, but is rather favorable to the evaporation of water from the surface of the body.—19 *C*, VIII., 175.

VERTEBRATES FOUND IN THE DEPOSITS OF THE EOCENE LAKE IN NEW MEXICO.

Professor Cope, in a preliminary report to Lieutenant Wheeler, in charge of the United States Geographical Survey west of the one hundredth meridian, enumerates eighty-three species of the vertebrate animals as having been discovered by him in the deposits of the eocene lake that once covered the northern and western parts of New Mexico. Of these eight are fishes, twenty-four reptiles, and fifty-one mammals. Of the whole number, fifty-four species were introduced for the first time to the notice of scientists. This fauna is nearly related to that of the eocene of Wyoming in many respects, but differs in the distribution of many of the genera. Thus *Paleosyops agenus*, abundant in Wyoming, is not found in New Mexico, while *Bathmodon*, which does not occur in the Bridger beds of Wyoming, is the most abundant type in New Mexico, parts of over one hundred and fifty individuals belonging to seven species having been found by Professor Cope. Small tapiroid animals of the genus *Oro-*

hippus are abundant, and at least eleven species of lemurian monkeys were found. The carnivorous animals discovered number eleven species, some of which were as large as the jaguar, or larger. They are all quite distinct from living genera excepting one genus, which is related to the Asiatic civet. Some very small insectivora were also found, one of which is not larger than a small shrew. The waters of the lake abound in turtles, crocodiles, and gar-fishes.

A STRANGE RACE OF PEOPLE DISCOVERED IN INDIA.

The report of the Indian Trigonometrical Survey contains matter of exceptional ethnological interest in its account of an odd people living in the hill jungles of the western Ghats, to the southwest of the Polanei Hills. Stories had been heard of a strange dwarfish people in the southwestern corner of the Tinnevelly district, but it was not until recently that any thing definite was known about them, when Mr. Bond, a member of the survey, secured an interview with a man and woman. Of these the man was supposed by Mr. Bond to be twenty-five, and the woman eighteen years old. The man is four feet six inches high, twenty-six and a quarter inches round the chest, and eighteen and a half inches horizontally round the head over the eyebrows. He has a round head, coarse, black, woolly hair, and a dark-brown skin. The forehead is low and slightly retreating; the lower part of the face projects like the muzzle of a monkey; and the mouth, which is small and oval, with thick lips, protrudes about an inch beyond his nose. He has short bandy-legs, a comparatively long body, and arms that extend almost to his knees. The back, above the hips, is concave, making the buttocks appear to be much protruded. The hands and fingers are dumpy, and always contracted, so that they can not be made to stretch out quite straight and flat; the palms and fingers are covered with thick skin (more particularly the tips of the fingers), and the nails are small and imperfect. The feet are broad, and thick-skinned all over. The hairs of his mustache are of a grayish-white, scanty and coarse, like bristles, and he has no beard.

The woman is four feet six and a half inches high, twenty-seven inches round the chest above the breasts, and nineteen and a half horizontally round the head above the brows; the

color of the skin is sallow, or of a nearly yellow tint; the hair is black, long, and straight, and the features well formed. There is no difference between her appearance and that of the women common to that part of the country. She is pleasant to look at, well developed, and modest. Their only dress is a loose cloth, and they eat flesh, but feed chiefly on roots and honey. They have no fixed dwelling-places, but sleep in any convenient spot, generally between two rocks, or in caves near which they happen to be benighted. They make a fire, and cook what they have collected during the day, and keep the fire burning all night for warmth, and to frighten away wild animals. They worship certain local divinities of the forest—Rákas, or Rákári, and Pé, after whom the hill is named Pé-malei. The woman cooks for and waits on the man, eating only after he is satisfied.—12 *A*, *May* 27, 1875, 73.

BOYD DAWKINS'S "CAVE HUNTING."

According to a review by the *Athenæum* of Boyd Dawkins's "Cave Hunting," the evidence of the cave deposits indicates the following facts, as far as our knowledge extends: "The climate and geography of Europe in ancient times were altogether different from those of the present day. We may infer, with a high degree of probability, that a paleolithic people migrated from the East into Europe along with the peculiar pleistocene fauna in the *preglacial* age, and disappeared with the same arctic mammalia, leaving behind them as their representatives the Esquimaux, who were cave-dwellers, and occupied themselves in hunting and fishing, and supporting life in a rigorous climate.

"An indefinite interval of time, which can not be measured by years, separated those paleolithic peoples from their successors of the prehistoric times. These latter, or *neolithic* people, arrived also from the East along with cereals and domestic animals. They were cave-dwellers, and also used caves as sepulchres, and we know more of them than of their forerunners. They were non-Aryan, swarthy (*melanochroi*), dolichocephalic, and short, and distinguished in many instances by *platycnemism* (a peculiar flattening of the shin). They were pastoral, herdsmen and farmers; and, when caves were not to be obtained, they buried their dead in chambered

cairns. They disappeared, and left as their representatives the Basques, Berbers, and Kabyles.

"Another wave of migration swept over Europe from the East, this time Aryan, fair (*xanthochroi*), brochycephalic, tall, broad-shouldered Celts, who brought with them metallurgic skill, bronze and iron, and a higher stage of civilization. The ancient Basque continent was submerged by the Celtic populations advancing steadily westward, and certain parts of the non-Aryan peoples were left insulated, as the Ligurians, Sikani, Sardinians, etc. Similarly the Belgæ invaded the Celts, and the Germans in their turn pressed southward and westward on the Belgæ, driving away or absorbing the inhabitants of the regions they conquered."—15 *A*, *No.* 2458, *Dec.* 5, 1874.

HUMAN FIGURE ENGRAVED ON REINDEER HORN FROM THE CAVE OF LAROCHE-BERTHIER.

Among recent discoveries in the reindeer caves of France is that of a human figure engraved upon a reindeer horn, found in the cave of Laroche-Berthier, of apparently the same epoch as that of the Madeleine. This, although very rude in its execution, as figured by De Launay, is yet quite recognizable. It is not, however, of a character to give us any idea of the general appearance of the people of its day.—20 *B*, 1875, 192.

MR. GEORGE LATIMER'S ARCHÆOLOGICAL COLLECTION FROM PORTO RICO.

A very interesting and important addition to the ethnological branch of the National Museum at Washington has lately been made in the form of a large collection of objects of stone from Porto Rico. This was gathered during a period of many years by Mr. George Latimer, an American citizen residing in that place, who spared no pains nor expense to secure whatever could be obtained from the ancient graves in the island. The most noticeable features in the series consist of about fifty oval stone rings of much the size and shape of horse-collars, all variously carved and ornamented. There are also many statuettes, carved heads, triangular stones with faces of animals carved at either end, some pottery, and numerous axes and chisels—some of exquisite beauty, and polished to the highest degree. Many of them are of the green jade so much sought after by archæologists. Numerous ap-

plications have been made, and large sums of money offered by foreign societies for this collection; but Mr. Latimer declined to give any indication as to its proposed destination, and not until after his decease, in November last, was it ascertained that he had left it to the National Museum. The collection filled twenty-six boxes and barrels. It was carefully packed by the executors, and transmitted to Washington.

THE LOWEST OF KNOWN HUMAN FORMS.

The lowest of known human forms is represented by a lower jaw discovered several years ago in a cave near Naulette, Belgium. It possesses the massive form characteristic of monkeys, and, like those animals, has large canine teeth and little or no chin. There is, on the other hand, no interruption in the dental series, thus resembling man. It was for some time denied that this jaw is human, but it is now fully admitted to be such. Unfortunately the remainder of the skull is unknown. Subsequently a portion of a cranium, with other bones of man, were discovered in a volcanic deposit near Denise, near Puy-en-Velay, which were thought to indicate an inferior type, and one contemporary with the activity of the volcanoes of that region. When the French Scientific Congress met at Puy, these remains elicited much discussion, and their antiquity was denied. Specimens of different form and character were produced which were imbedded in the same material, but were apparently modern. Recently Dr. Sauvage has given the subject a thorough examination. He finds that the last-mentioned specimens are of doubtful authenticity, and may have been manufactured. The original ones he believes to have been buried in a volcanic eruption, and to represent a race contemporary with the activity of the volcanoes. The cranium is of the same low type as the race represented by the Neanderthal and Cannstatt skulls, having thick walls, a retreating forehead, and huge superciliary arches.

STONE KNIVES WITH HANDLES, FROM THE PAI-UTES.

Among objects of interest lately received at the National Museum in Washington are thirty-six stone knives, with handles, obtained by Major Powell from the Pai-Utes. The

blades are oblong triangular and oblong tongue-shaped, acute, two or three inches in length, and so much resemble many of the so-called lance and arrow heads in collections that it becomes necessary to modify our views as to the latter articles. The handles are three to five inches long, and a notch half an inch deep at one end receives the stone, which is held in place by a tough pitch melted into the slit and around the joint, sinew being sometimes wrapped round in addition.

PREHISTORIC REMAINS FOUND NEAR SCHAFFHAUSEN.

A remarkable deposit of prehistoric remains has lately been found in the cavern of Thäingen, in the Canton of Schaffhausen, in Switzerland. Among the bones of animals met with were those of the European fox, and, what is very remarkable if true, those of the American fox (*Vulpes fulvus*), as also of the wolf, the dog, the brown bear, the wild-cat, the lion, the marmot, the European hare, the reindeer, the ibex, the chamois, the deer, the bison, the primitive ox, the pig, the horse, the elephant, the rhinoceros; and of birds, those of the ptarmigan.

There were also some very excellent carvings, upon bone, of the horse, representing a species little different from our own. Three distinct deposits were found in this cavern. The lower or gray layer contains the bones of the elephant, the hairy rhinoceros, the glutton, and the *Bos priscus*. The two superior layers consisted of angular fragments and rolled pebbles, with many bones. No remains of human industry are found in the middle and lowest layers.—1 *F*, *October* 15, 1874, 159.

ARCHÆOLOGY OF THE MAMMOTH CAVE.

A new phase in the archæology of the United States is shown by the researches of Mr. Putnam in the caves of Kentucky, as he has found that many of the caverns there were used for burial, as in Europe, and that others were used for habitations. Many relics and skeletons have been brought to light by his investigations, and further research, which will be carried on next year in connection with the geological survey of the state, will undoubtedly add much of importance to the archæology of our country. Enough evi-

dence has already been obtained to prove that the caves were very extensively used by an early race of men, but the race to which the remains should be referred is not yet determined. In his investigations in the vicinity of a group of mounds in Monroe County, Kentucky, Mr. Putnam was also quite fortunate in finding a peculiar mode of burial that has not before been noticed, inasmuch as the bodies, in one case ten in number, were buried in a circular grave, made by placing erect slabs of limestone around a floor laid with thin stones. The bodies had all been placed in the grave at the same time, and evidently in a sitting posture, with their backs against the slabs. The skulls show a race remarkable for the shortness of their heads, and in one case at least exhibited a posterior flattening. The bones of the skeletons were quite thick and massive, and the shin-bones were remarkably flat.

EFFICIENCY OF ANCIENT WEAPONS.

An interesting experiment was recently made by the directors of the St. Germain Museum, in Paris. Certain implements of war, constructed from designs on Trajan's column, were tested, and it was found that the catapult threw arrows to a distance of 300 yards, and hit a mark regularly each time up to 180 yards. The same can be said of the onagea, which sent stones of one and a half pounds to a distance of 180 yards with astonishing precision. The initial velocity with which the stones were sent was calculated to be more than sixty yards per second.—12 *A*, X., 273.

THE SACRED FIRES OF THE PUEBLO INDIANS OF TAOS.

The *American Sportsman* of October 17 gives an interesting account of a visit to the Pueblo Indians of Taos, wherein the author describes one of their council chambers, or "estufas," as follows: "We were very curious to enter their council chambers, in which the same fire is kept constantly burning for Montezuma; but it was only after a great deal of persuasion, backed up by a promise of 'cuatros reales,' that the 'Capitas de la Guerra' consented to show us the one belonging to him by virtue of his office. We descended by a long ladder to the chamber, which is underground, and found ourselves in a bee-hive-shaped room with an arched ceiling.

All around the wall was a mud bench, and in the centre was a shallow pit containing ashes, with fire underneath. Just behind the fire-place was an altar, shaped like the upper part of a cross, and built of mud. The entrance to this curious room is defended by a sort of stockade, open at one side, the passage being just large enough to permit a person to pass. When councils are held, this post is occupied by a sentinel to prevent the entrance of the profane. Our friend, the war chief, said he let us in because we were Americans, but that no Mexican should ever enter. In all, we found five or six of these estufas in the village, belonging to the different head men, and used by them as council chambers."—*American Sportsman, October* 17, 1874.

ANCIENT MODES OF BURIAL AMONG THE INDIANS OF NORTH CAROLINA.

Mr. Wilcox communicates to the Academy of Natural Sciences of Philadelphia the account of an unusual mode of burial which was formerly practiced among the Indians of North Carolina. He states that in numerous instances burial-places have been discovered where the bodies had been laid with the face up, and covered with a coating of plastic clay about an inch thick. A pile of wood was then placed on top and fired, consuming the body and baking the clay, which retained the impression of the body. This was then lightly covered with earth.—*Pr. Acad. Nat. Sci., Philadelphia*, 1874, 165.

KITCHEN-MIDDING IN THE ISLAND OF ST. GEORGE, NEAR ATHENS.

Dr. Von Dücker has lately announced the occurrence of a kitchen-midding on the island of St. George, near Athens. This, however, is shown by Gaillardot to be the remains of an ancient manufactory of Tyrian dyes. Other shell heaps of a similar character have been found. One of them, located on the site of ancient Sidon, is a bank about four hundred feet in length, consisting entirely of the remains of *Murex trunculus*, and other species like it, furnishing a valuable dye. The *M. trunculus* is known to have yielded the most precious coloring matter used in the Tyrian dye, but it is suggested that the species was employed to produce the various other

shades, such as red, yellow shot with black, etc.—15 *A, October* 31, 1875, 483.

DISCOVERY OF ANCIENT WELLS NEAR ASHILL, ENGLAND.

An extremely interesting archæological discovery has lately been made near Ashill, in England, of three wells on the site of an ancient Roman camp at Ovington, the mouths of which were covered with solid oaken frames. One of these was excavated to the depth of forty feet, and in it were found first a bronze fibula, some Samian ware, broken pottery, stones, and bones of cattle, with some other articles. Lower down the contents consisted of layers of urns, of which fifty were nearly perfect, and most of them of great beauty. They had been carefully let down into the hole, some of them inclosed in baskets; and the urns in each layer were arranged in different ways. At the lowest level several of the urns had still attached to them the remains of the cord with which they were let down into position. It is thought that these pits were formerly used for sepulchral purposes, and afterward hastily filled in with rubbish and covered up.—15 *A, October* 31, 1874, 483.

HYDE CLARK'S COMPARISON OF AMERICAN AND ACCADIAN LANGUAGES.

An elaborate paper was read before the Anthropological Institute, May 26, 1874, by Hyde Clark, and has since been published in a pamphlet, entitled "Researches in Prehistoric and Protohistoric Comparative Philology, Mythology, and Archæology, in Connection with the Origin of Culture in America, and the Accad or Sumerian Families." The design of the author is, in his own words, "to bring archaic philology into union with those nascent studies of anthropology, archæology, and mythology which have met with acceptance and popularity." He has elsewhere drawn attention to the similarity between the Agaid of the Nile and the Abkhass of the Caucasus with the Omagua and Guarani of Brazil, and in this treatise he enforces the unity of the race, and the history of migration, by reference to philological proofs. He first draws attention to the Pygmæan and other so-called prehistoric races of North and South America, of Africa, and of the islands of the Pacific Ocean, and then by

parallels of culture he passes from tribes of the Old World to those of the New, somewhat similarly to the plan pursued by E. B. Tylor in tracing the growth of culture, and by Colonel Lane Fox in following the evolution of implements and weapons. He regards, for philological purposes, Egyptian, Sumero-Peruvian, Chinese, Thibetan, and Dravidian languages as protohistoric.

In the prehistoric period an idea was represented by three or four words, and a word stood for three or four ideas. We find that words are interchangeable, and that it is necessary to study their morphology for the purpose of understanding the equivalents or real connection of roots in various languages. In no department is this better illustrated than in animal names. Thus, among the Aryans, fire, dog, tiger, sun, star, and snake all conform, on the basis of their devouring every thing which they seize. Of this theory the author adduces numerous illustrations. In addition to resemblances of language between the continents, the author enforces his opinions by parallels of racial characters, by similar customs, by their works, and by their religious observances.

THE ANTIQUITY OF HUMAN REMAINS.

Mr. Evans, in the discussion of the alleged circumstances of the occurrence of human remains in deposits indicating the existence of man prior to the glacial period, is of the opinion that the human fibula found in the Victoria Cave, near Settle, England, is hardly enough to prove such antiquity, as this may possibly have been accidentally redeposited at a later period. Mr. Geikie, however, insists that the paleolithic deposits are in no way post-glacial, but are generally of preglacial and interglacial age. Mr. Evans is of the opinion that, although the evidence so far is not yet satisfactory, there is no reason why better may not be found, and he thinks that this is to be sought for in a warmer climate and among a more luxuriant vegetation.—13 *A*, *April* 24, 1875, 431.

THE SEMANGS, A PRIMITIVE RACE IN INDIA.

The Russian Geographical Society has received a letter from Mr. Miklucho-Maklay, from Singapore, dated April 13.

He reports that in the Semangs, a primitive and nomad race, gradually disappearing before Chinese and Malay civilization, he has proved the existence of a non-Malayan and a probably Papuan element. He is about returning to Russia for the purpose of publishing the results of his travels in New Guinea and other parts of the East Indies.—13 *A*, *June* 12, 1875, 607.

CRANIAL AMULETS.

Dr. Prunieres, in 1873, found in the dolmens of Marvejols (Lozère) some skulls, pierced, and in their cavities small rings of polished cranial bones. Since this discovery the attention of others has been drawn to the same subject. Baron Larrey, in a communication to the Academy of Medicine, describes trepanning among the Kabyles. General Faidherbe found two skulls in Roknia, Algiers, similarly treated. Mr. Squier presented to the Société d'Anthropologie a pierced skull from an ancient Peruvian huaca. M. Chil related at the Congress at Lille that he had found a perforated skull in the Canaries. In the *Gazette Hebd. de Médicine et de Chirurgie* for 1874 is an account of trepanning among the South Sea Islanders. The Greeks were familiar with the operation, and the word from which the name is derived, τρεπω, also describes the universal method of its performance. The motives assigned for this practice, which was performed upon infants and youth, upon the living and the dead, are various. That a blow from a stone battle-axe, or from a sling, pierced the skull, and deposited the round fragment in the cavity, is disproved by the fact that many of these wounds are healed, and the wound is unaccompanied by fracture. So we are to assign either a surgical or a religious reason; and inasmuch as religion and medicine go hand in hand among savage tribes, a mixed motive, or a purely religious one, seems to accord best with all the facts. A demon being the cause of disease, when the pain is in the head the Kabyles say they open the skull to let the disease out. The operation is not more painful than many of the initiatory rites of savages, only dangerous after violent contusion, and certainly not as fatal as the disemboweling practiced among the West Coast Africans. But the restriction of the operation to the young and to the dead points unmistakably to initiatory and funereal

rites, and to the existence of ecclesiastical castes. The round fragments are all pierced in the centre, as though designed to be worn as amulets or relics. The singular habit of perforating, after death, the skull of one who had been trepanned while living, and of placing the bone rings in the skull of the dead, says M. Bertillon, points to their belief in the immortality of the soul, and the desire to furnish the subject with a whole cranium in the habitations of the blessed.—20 *B*, 1874, 383–396, and 13 *B*, *April* 10, 1875.

ORIGIN AND TRUE CHARACTER OF CERTAIN STONE WEAPONS.

In the Turkish collection of geological specimens and petrifactions at the Vienna Exhibition there were certain sharp objects, made of flint, about six inches long, one inch broad, and one fourth of an inch thick, which were, invariably, at once pronounced to be flint knives of the stone age by those who had made a study of such objects. As explained by Dr. Hammerschmidt, however, they proved to be modern articles, employed by the million, where wheat is grown, in Roumelia, Anatolia, Syria, etc., by the peasantry in the manufacture of a kind of thrashing-machine, in the form of sleds armed with these knives, which are drawn over the grain by oxen or men. They are very similar to the machines employed by the Romans, which were doubtless carried in all directions by their colonists.—7 *C*, IX., 1874, 568.

CRANIA-ETHNICA.—THE CRO-MAGNON RACE.

Messrs. Quatrefages and Hamy have published the second livraison of their great work upon the human crania, entitled *Crania-Ethnica.* The first part was devoted to a group to which they applied the names of the Canstatt races, and embracing such unusual forms as the Neanderthal, Nagykap, and other historic skulls. The present is devoted to what they call the race of the Cro-Magnon, in which they include human crania from the Madelaine, Laugerie-Basse, Bruniquel, Soloutre, etc. As in the Canstatt race, the authors consider the Cro-Magnon race as having continued in existence from the period when they were first found to the present time, being represented now by a few individuals, especially in Africa. The megalithic tombs of Roknia contain a large number of skulls similar to the Cro-Magnon, and the type is

seen among the Kabyles and the Guanches of Teneriffe.—3 *B*, *April* 2, 1874, 663.

EVOLUTION OF THE HOG.

The predecessors or ancestors of the hog, Babirussa, and of similar existing animals, are being gradually brought to light by modern paleontological studies. One of these, nearest the domesticated form, has been found in the miocene of France, and is referred to the genus *Palæochœrus.* It is also related to the peccaries, which appear to have lived during the same early period in North America in considerable abundance. Their existence in South America at the present time is one of many indications that that region has not advanced in respect to its fauna as rapidly as our own and the old continents. Another miocene genus of hogs is the *Elotherium*, which has left remains in France and North America. The common species of the Nebraska beds is the *E. mortonii* of Leidy, which was as large as a pig. Its front teeth are much developed, at the expense of the hinder ones; and it had bony tuberosities on the under jaw, in the positions now supporting wattles in the hog. Professor Cope, of Hayden's United States Survey, discovered during the past season in Colorado much the largest species of *Elotherium* yet known. The skull was longer than that of the Indian rhinoceros, and the tuberosities of the lower jaw were greatly developed. The front pair formed divergent branches on the lower front of the chin, so that it appeared to bear a horn on each side, which the animal doubtless found useful in rooting in the earth. The species was semi-aquatic in its habits, like the hippopotamus and dinotherium; but while these are furnished with extraordinary developments of the lower incisor teeth for tearing up their food, the *Elotherium ramosum* is the only animal known which possessed horns in the same position and for the same purpose. A still older type of hogs—which may claim to be the predecessor in structure as well as in time of all known genera—is the *Achænodon*, Cope, from the eocene of Wyoming. The *A. insolens* was a powerful beast, larger than a bear, with a comparatively short head, and with the uninterrupted series of teeth which belongs to all the oldest forms of the mammals and to the higher quadrumana.

REPRESENTATIONS OF ANIMALS ON BONE AND HORN BY MEN OF THE REINDEER PERIOD.

Great interest is attached by archæologists to the representations of animals by men of the reindeer period of France, as executed upon bone plates of reindeer horn, etc., and the publication of the design representing unmistakably the hairy mammoth, or fossil elephant, not long since attracted universal attention. More recently other figures of the same character have been published, in an article by M. Louis Lartet upon some specimens belonging to the collection of his father, M. Edward Lartet. This consists of two sketches of the fossil elephant, made on either side of a polished plate of bone, showing unmistakably the trunk, tusks, and other characteristics; and as the two figures were in different attitudes, it would seem that they were probably representations of the same individual.

M. Lartet sums up all the figures of prehistoric carvings known to him of the fossil elephant, remarking that the first one discovered was on a plate of ivory taken from the cave of La Madelaine, in Perigord. A second was found at Laugerie-Basse, in Perigord, and a third specimen, from Bruniquel, is a little more doubtful as to its identification. M. Lartet in the same article reproduces an engraving of what he supposes to be a glutton or wolverine.—20 *B*, 1874, 33.

ORIGIN OF THE HORNS OF THE DEER.

The origin of the horns of the deer has recently been accounted for, especially in respect to the peculiar periodicity of their growth and subsequent shedding. It is well known that during the early winter male deer are hornless, but toward spring the tissues at certain points of the frontal bones thicken, and the enlarged arteries bring additional nutritive material, especially phosphate of lime, for the construction of horns. These grow so rapidly that horns weighing as much as seventy-two pounds have been produced in ten weeks. The lowest types of deer now living have unbranched horns, but shed them like the others. Some years ago there was discovered in the upper miocene beds of France an animal which might have been a deer but for the fact

that it did not shed its horns when living. It was called *Dicroceras dichotomus.* Subsequently a similar species was obtained by Dr. Hayden in Nebraska, and was named *Antilope furcata.* A species of different character was discovered at the same time, and it had apparently shed its horn, and had a new one united to its base by a bur, as in the deer. It was described as *Cervus warrenii.* Professor Cope, of the Wheeler survey, rediscovered these species in New Mexico, along with two others not previously known, and referred them all to the genus *Dicroceras*, on account of the following observations: He noticed that in about half the individuals of a given species the horns are attached to the skull without interruption, as in an antelope, while in the others it had evidently been broken off and reunited. A mass of bony projections was developed at the point of union, producing a small bur, as in the living deer. It was evident that the cause of these appearances was an ordinary fracture and subsequent anchylosis, and it was supposed that the animals had broken off their horns in combats at the rutting season, in the spring of the year. It was inferred, further, that the excess of growth necessary to repair became, like many other animal phenomena, periodical, and that it was followed by feebleness and death of the horn. The latter was then cast off like any ordinary slough of dead bone.

NEW TERTIARY MAMMALS.

Professor Marsh, in the appendix to the *American Journal of Science*, presents a fourth notice of new tertiary mammals, among the most interesting of which are *Lemuravus distans* and *Laopithecus robustus*, two new genera and species of quadrumana. These were obtained on a recent expedition of the author to the Bad Lands of Nebraska. The last mentioned—a species of monkey—is represented by a single lower jaw, of about the size of that of a coati mundi.

Under the name of *Diceratherium*, Professor Marsh has described a distinct species of rhinoceros, provided with horns, the first of this character hitherto described in America. Here the horns were placed transversely, as in modern ruminants, and the remains indicate an animal of about two thirds the size of the Indian rhinoceros. Two other species of the genus, of less size, were also indicated.

The total number of new species of extinct mammals amounts to twelve, and of genera to eight.

PROFESSOR MARSH ON A NEW ORDER OF MAMMALS: TILLODONTIA.

Professor Marsh, on the 17th of February last, made a communication to the Connecticut Academy on a new order of eocene mammals, for which he proposes the name of *Tillodontia.* These are among the most remarkable vertebrates found in the American strata, and seem to combine several distinct groups, such as carnivores, ungulates, and rodents. In one genus, *Tillotherium*, the skull has the same general form as in the bears, and in its structure resembles that of the ungulates. In each jaw there is a pair of large, cutting incisors, covered with enamel, and growing from persistent pulps, as in rodents. The skeleton is most like that of the carnivores, especially the bears. The radius and ulna and the tibia and fibula are distinct. The other genera of this order have less distinctive characters. Some of the animals were as large as a tapir.

There appear to be two distinct families of the new order; one of them, which Professor Marsh calls *Tillotheridæ*, in which the large incisors grow from persistent pulps, while the molars have roots; and the *Stylinodontidæ*, in which the teeth are without roots.—4 *D*, *March*, 1875.

EOTHERIUM ÆGYPTIACUM, A NEW FOSSIL SIRENIAN.

Professor Owen has presented a communication to the Geological Society of London upon a peculiar form of "seacow," a sirenian mammal, named by him *Eotherium ægyptiacum*, which existed in the shallow waters from which the upper part of the nummulitic limestone of Egypt was deposited. The portion of the remains obtained shows that the animal had a relation to the recently extinct *Rhytina stelleri* and to the *Halitherium.*—13 *A*, *November* 21, 1874, 568.

SIR VICTOR BROOKE ON CERVUS BROWNII.

Sir Victor Brooke, a high authority in every thing relating to the *Cervidæ*, or the deer family, takes occasion to criticise the supposed species of fossil deer described by Mr. Boyd Dawkins under the name of *Cervus brownii.* This he shows,

by perfectly satisfactory evidence, to be identical with the common *Cervus dama*, or fallow deer, of Europe. If this view be correct, then the fallow deer existed in England during the pleistocene period; but whether it became extinct in Northern Europe before the advent of prehistoric man, or whether it continued to exist in these islands even at the commencement of the Roman occupation, are questions yet to be solved.—12 *A*, *January* 14, 1875, 211.

A NEW KANGAROO FROM NEW GUINEA.

A new species of kangaroo, of the genus *Dorcopsis*, has lately been obtained from Southeastern New Guinea by Dr. Albertis, and described under the name of *Dorcopsis luctuosa*, this forming the second species of the genus now known from New Guinea. The island of Aru has long been known as possessing a species of true kangaroo, with a naked nose, described under the name of *Macropus brunii*. This is a remarkable fact in geographical distribution, as all the others known are natives of Australia and its more immediate surroundings.—15 *A*, *February* 6, 1875, 195.

DR. COUES ON THE MICE OF NORTH AMERICA.

Dr. Coues has published in the Proceedings of the Philadelphia Academy a synopsis of an elaborate work by him upon the mice of North America, based upon the many thousands of specimens in the Smithsonian Institution. In this he considerably reduces the alleged number of species, although describing some that he considers new. The genera retained by him for the American forms are *Neotoma*, *Sigmodon*, *Hesperomys*, *Ochetodon*, *Evotomys*, *Arvicola*, *Synaptomys*, *Myodes*, *Cuniculus*, and *Fiber*, some of them with several sub-genera. Twenty-eight species, some of which have numerous varieties, are recorded by Dr. Coues.—*Pr. Acad. Nat. Sci., Philadelphia*, 1874, 173.

BARNACLES ON BIRDS.

Although barnacles attached to floating objects are known to be transported to great distances, thus far no case of transportation out of water has been recorded. During the recent cruise of the Italian frigate *Magenta*, however, several specimens of a stormy petrel, *Priofinus cinereus*, were shot in

the southern portions of the Atlantic and Indian oceans, with numerous fragments of a species of barnacle attached to the abdominal feathers. It is supposable, therefore, that the larvæ attached themselves to these birds, which swim along the surface of the water, and dive after their food, instead of fixing themselves on inanimate objects, and that they are thus also, most probably, best preserved from the attacks of other marine animals. Upon closer investigation the very interesting and unexpected discovery was made by Professor Tozzetti that these barnacles are of a new genus, characterized by a provision for the retention of moisture, without which it would be impossible for them to survive so long a removal from the water.—19 *C, September* 12, 1874, 352.

FOOD OF THE MASTODON.

Dr. Hunt gives an account, in the Proceedings of the Boston Society of Natural History, of the contents of the stomach of a mastodon lately found in Wayland, New York. These consisted of remains of both cryptogams and flowering plants, exhibiting distinctly the vegetable characters. No sphagnum was found in the deposit. The evidence was that the animal had eaten his last meal from the tender mosses and boughs of the flowering plants growing on the banks of streams and margins of swamps, and that pines and cedars formed no part of his diet.—*Pr. Bost. Nat. Hist. Soc.*, XVII., 1, 92.

DISCOVERY IN NEWFOUNDLAND OF BONES OF THE GREAT AUK.

According to *Nature*, some bones of the great auk have lately been found in the Funk Islands, off the coast of Newfoundland, and carried to London. Unfortunately, however, they are not in a very good state of preservation. It was from this locality that two mummied auks were obtained some years ago, furnishing complete skeletons. One of these is in the Museum of Comparative Zoology at Cambridge, and the other, we believe, was sent to the British Museum in London.—12 *A, January* 24, 1875, 216.

HABITS OF KINGFISHERS.

Dr. C. C. Abbot, in *Nature*, combats Mr. Darwin's statement that the kingfishers, having caught a fish, "always

beat it until it is killed," by the counter-statement that he had "never seen a kingfisher take its food otherwise than by swallowing it whole while yet upon the wing." He watched, in 1873, the belted kingfisher for eighty-three days, seeing it dive one hundred and sixty-six times, "and either every plunge was unsuccessful, or the bird swallowed, before alighting, every fish he had taken." In 1874 he saw them dive about four hundred times, and in eighty-six instances the bird beat the fish against the limb on which it stood before swallowing it.

THE FLIGHT OF BIRDS.

Monsieur Marey has made a series of observations which prove how important a part the onward movement of a bird plays in increasing the efficiency of each stroke of the wing; for, supposing that in its descent the wing did not continually come in contact with a fresh volume of air, it would act at a disadvantage, because the downward impulse, which at the commencement of each stroke it gives to the air below, would make that air, by so much, a less efficient resisting medium; while by continually coming in contact with a fresh body of air, the wing is always acting on it to the best advantage. For this reason, when a bird commences its flight it turns toward the wind, if possible, to make up for its lack of motion on starting.—12 *A*, IX., 1874, 390.

PROFESSOR ALFRED NEWTON ON THE MIGRATION OF BIRDS.

The desire to refute what he considers a very absurd theory in the *London Times* as to the migration of birds has induced Professor Alfred Newton, the well-known ornithologist, to address to *Nature* a communication on the subject of the migration of birds. He stigmatizes as absurd the idea, advanced by the writer in question, that birds, congregating on the coast, are seized with a sudden mania to fly upward, caused, as he supposes, by some atmospheric change coinciding with the warm south wind moving in a high stratum, into which the birds soar with an involuntary motion of their wings. This motion, involuntary like that of the heart, is continued for many hours, and the birds fly swiftly along until the paroxysm passes off, when they at once begin to descend, many of the feeble ones dropping into the sea.

It is the more easy to agree with Professor Newton in his criticism on this theory, as the phenomena of migration in North America show, not a paroxysmal impulse, but a long-continued movement, which lasts for weeks and even months, during which the birds make progress in definite lines, usually proceeding in the autumn to well-established wintering grounds, from which they return in the spring to almost the precise spot whence they at first started. In opposing the hypothesis of the *Times* correspondent Professor Newton at the same time confesses his ignorance in regard to the phenomenon, and remarks that the attention of observers should be directed to the following points:

First, the original cause or causes of migration. In some cases he thinks that scarcity of food is a sufficient and a most obvious cause. As food grows scarce toward the end of summer, in the most northern limits of the ranges of species, the individuals affected thereby seek it in other countries. In doing this they crowd out other individuals, and these, in turn, press upon still another zone, resulting in a stampede of the birds inhabiting a vast extent of country. He, however, does not find that the return movement is to be explained by any such hypothesis, since there is always an abundance of food in the winter quarters of the migrants, who leave for the North, where the ground may be still covered with snow, and where they are subjected to great inconvenience in their search for food. Next, the mode or modes of migration; not only whether different birds migrate in the same manner, but whether the same species maintain the same peculiarities throughout. The great question, however, is how birds find their way back to their old homes, returning after a journey of thousands of miles to the very spot where they were hatched, or where they had nested the previous season, and arriving at a given point on almost the same day in many successive years.

An hypothesis was presented some years ago by Middendorf, an eminent Russian naturalist, who believed that he had found in the magnetic currents circulating between the north and south poles of the earth the cause of the phenomena in question. This answers very well for the species which actually make use of a movement in the direction referred to, but fails to explain the case where, as in many

countries, such migration is more nearly east and west than north and south.

NEW SPECIES OF A NEW GENUS OF SERPENT.

A new species of a new genus of serpents, collected by Lieutenant Wheeler's expedition in Arizona during the field season of 1874, has just been identified and named by Professor E. D. Cope. It is called *Monopoma rufipunctatum*. The rostral shield of this new genus resembles that of *Phimothyra*, and the lateral head shields those of *Cyclophis æstivus*. It is, however, more like *Eutænia* in general character. This is a very interesting discovery.

NEW SERPENT FROM FLORIDA.

Mr. S. W. Garman describes, in the Proceedings of the Boston Society of Natural History, a new American species of serpent from Florida under the name of *Helicops alleni*.—*Pr. Bost. Nat. Hist. Soc.*, XVII., 1, 92.

RESEMBLANCE OF EXTINCT TORTOISES TO LIVING ONES.

A remarkable announcement is made by Dr. Günther to the effect that the remains of extinct species of gigantic tortoises in the Mauritius and the island of Rodriguez have a very close affinity to the living species of the Gallapagos Archipelago, and differing from other tortoises of the same region in having a flat cranium and a truncated beak. According to Dr. Günther, the presence of these allied tortoises at points so remote from one another can be accounted for only by the belief that they are in each case indigenous.—4 *D, November*, 1874, 403.

THE HYBRIDIZATION OF SALAMANDERS.

Professor Gervais, of the Jardin des Plantes, instituted a number of experiments in the hybridization of various species of aquatic salamanders. He mingled males and females of the European Tritons of several species; but the eggs were not fecundated, and soon died. The eggs of a siredon, or undeveloped *Amblystoma*, from North America, were successfully impregnated by the males of the European *Triton cristatus*, and were deposited in large numbers. Some thirty young hatched from these, and became objects of much curiosity.

They were veritable hybrids, but presented the characters of the male *Triton* more distinctly than those of the female *Amblystoma*. In spite of the utmost care, they all perished as the time approached for undergoing their metamorphosis. In a subsequent year the experiment met with a similar result—the larvæ attained some size, but died before the absorption of the gills.

FOSSIL SALAMANDER: SALAMANDRELLA PETROLI.

Professor Gervais has described a fossil salamander from the permian formation, to which he gives the name of *Salamandrella petroli*, on account of its occurring in the petroleum beds of the Permian formation. It is much more nearly related to the true salamanders than to *Cheirotherium*, and constitutes a new genus.—13 *B*, *February* 20, 1875, 191.

THE BATRACHIA AND REPTILIA OF NORTH AMERICA.

The Smithsonian Institution has published a memoir on the geographical distribution of the Batrachia and Reptilia of North America, by Professor E. D. Cope, which is based on the large collections of the National Museum. In this work the primary divisions of the earth, as proposed by Sclater and Huxley, are redefined, and the mixture of South American families and genera in the North American fauna regarded as sufficient ground for separating it as a primary division from Europe-Asia. The subdivisions or provinces adopted are six, viz.: the Eastern, from the Plains to the Atlantic, as far south as the isothermal of 77°; second, the Austroriparian, extending from the Rio Grande to the Atlantic, south of the isothermal of 77°; third, the Central, extending from Texas and the Sierra Nevada to the eastern boundary of the Plains; fourth, the Sonoran, embracing New Mexico, Arizona, and a part of Nevada; fifth, the Pacific, all west of the Sierra Nevada; and, lastly, the Lower Californian, covering the peninsula of that name. Of these the central is the poorest in reptilian life; the two eastern provinces are distinguished for the abundance of the species of salamanders and tortoises; and the Sonoran and Pacific for the abundance of lizards. The Sonoran province is remarkably poor in salamanders and tortoises, while the Pacific district, with few tortoises, abounds in salamanders. The Austroriparian is the

head-quarters of the toads and moccasins; the Sonoran is the centre of variation of toads, *Scelopori*, horned lizards, and rattlesnakes. A great number of species is confined to this division. The snake-like batrachians belong exclusively to the Austroriparian district, the range of the genus *Siren* being co-extensive with its boundaries. A few Mexican genera extend east along the Gulf as far as Florida, and a few others of Sonoran character extend south into Mexico. The Lower California district is peculiar in its boæform serpents and large iguanas.

On the whole, the North American fauna is peculiar in its salamanders; Old World in its frogs and most of its turtles; and South American in most of its snakes and lizards, and some of its turtles.

REPORT OF THE OCCURRENCE OF LARGE COD-FISH OFF MAZATLAN.

Land and Water refers to the occurrence of some large cod-fish off Mazatlan, West Mexico, as having been caught in June, 1873, by officers of the British ship *Scylla*. The largest of these fish measured six feet in length and weighed 230 pounds, the others being of different magnitudes down to 85 pounds. This statement, however, requires confirmation. It is a question whether the fish were really cod, or some other fish of more tropical habit more or less resembling it.—2 *A*, *January* 2, 1875, 6.

GRAYLING IN THE AU SABLE RIVER, MICHIGAN.

The discovery of the grayling in the waters of the Au Sable River of Michigan, some years ago, has attracted much attention to this locality recently, and induced efforts to secure and multiply this fish in some more southern waters. Our knowledge of this species is due mainly to Mr. D. H. Fitzhugh, of Bay City; and by his invitation Mr. Fred Mather, the well-known fish-culturist, of Honeoye Falls, New York, visited the locality in his company on the 1st of April, 1874, but found that the eggs were not then ripe. On the 1st of May Seth Green went to the same region, at which time the fish had all spawned. He, however, dug out from the gravel about one hundred eggs, which he gave to Mr. Collins, of the Caledonia fish farm, to hatch out. These grew slowly at first,

but at the end of six months were much larger than brook trout of the same age. On the 6th of April of the present year Mr. Mather revisited the Au Sable River, remaining there until the 12th. On the 8th he took spawn from two fish, and on the 9th and 10th from several more. He brought away 8000 spawn and 40 yearlings, the latter about five inches long. He also packed 4000 eggs for Mr. N. W. Clark, of Northville, Michigan, and gave him a considerable number of fish. These eggs, at the latest accounts, were thriving finely, and the embryo was expected to hatch out very soon. —*Live Stock Journal, May*, 1875, 150.

RESPIRATION OF THE LOACH.

M. Rougemont, in speaking of the European fresh-water fish known as the loach (*Cobitis fossilis*), says that when one of these fish is placed in ordinary water it respires by means of its gills, in a normal manner; but whenever the proportion of oxygen falls below a certain minimum, the fish rises to the surface and there takes in air, while bubbles charged with carbonic acid escape at the anal orifice. It therefore appears that the digestive tube itself performs the functions of respiration, and that it is in this organ that the blood finds the oxygen necessary to its purification. This tube is thus equivalent to an air-bladder, and when filled with air the fish rises easily to the surface. The so-called air-bladder of the fish is a small bony receptacle, situated under the first vertebra, and it is believed, in view of the small volume of air it is capable of containing, that it is not a real air-vessel, but is simply a resonant chamber communicating with the organ of hearing, properly so called.—1 *F*, *October* 15, 1874, 162.

MONOGRAPH ON THE ANGUILLIFORM FISH.

M. Dareste has communicated to the Academy of Sciences of Paris a monograph upon the anguilliform fish, and especially the generas *Anguilla*, *Conger*, *Myrus*, *Murænesox*, and *Nettastoma*, which he finds to possess comparatively few of the anomalies observed in the subjects of a previous memoir on the *Symbranchidæ*. In *Anguilla*, to which the common eel belongs, he finds evidence of the existence of only four species. One of these, the *A. vulgaris*, is found throughout the whole northern hemisphere, both in the New and the Old

World, exhibiting certain variations, it is true, but none of a specific value.

The other species, which he considers as belonging to this genus, are the *A. marmorata* and the *A. mowa* of the Indian seas, and the *A. megalostoma* of Oceanica.

Of the genus *Conger* he allows but four species; namely, the *C. vulgaris*, *balearicus*, *mystax*, and *acutidens*, the first two of which he regards as cosmopolite, and found simultaneously in almost all waters.

The variations in the external appearance of the true eel he thinks are produced in large measure by peculiarities of the ossification of the bones. In some the bones are in a cartilaginous or rachitic state, from which results a shortening of the jaws, or other deformations that produce a special impression upon the external appearance of the animal. Other variations are produced in both the conger and the true eel by the extent of albinism and melanism, special features appearing in each.—6 *B*, *November* 2, 1874, 988.

LARGEST PIKE EVER TAKEN IN ENGLAND.

Mr. Buckland, in *Land and Water*, acknowledges the receipt of what he considers to be the largest pike ever taken in England, weighing thirty-five pounds, and measuring three feet ten and a half inches in length. From the best evidence he could gather, this was one of the survivors of a small number of pike, weighing about one pound and a half each, which were placed in Ripley Lake some twelve years ago. The roe weighed three and a half pounds, and contained over 43,000 eggs.—2 *A*, *October* 24, 1874, 320.

HABITS OF EELS.

In view of the many points that still remain to be ascertained in regard to the life history of the eel, a recent communication published in *Les Mondes* may not be without its interest, however doubtful some of its statements may be. According to the writer, M. E. Noel, a certain fish-warden near Rouen, has observed that at about the end of September the large eels leave the sources of all the rivers and descend toward the salt water, at which time they are covered with a much thicker coat of muddy mucus than usual. They do not go down entirely to the sea, but stop in brackish wa-

ter, where they can bury themselves a certain distance into the mud. There they knot themselves together, forming an enormous mass constantly in motion, the result of which is that the mucus becomes detached from them, and this, after a time, is found to swarm with myriads of little eels.—3 *B*, *May* 13, 1875, 79.

FOSSIL LEPIDOSTEUS.

Professor Gervais announces the discovery, among other fossils of the Paris Basin, of a species of true *Lepidosteus*—a genus of fishes now found living only in North America. He had previously made this suggestion, but somewhat doubtfully, and it is only quite recently that he has ascertained to his satisfaction that the species belonged where he had assigned it.—6 *B*, *October* 12, 1874, 846.

REPRODUCTIVE SEASON OF THE COD ON THE FAROE ISLANDS.

In a notice of the fisheries of the Faroe Islands, in the *Revue Maritime et Coloniale* for March, 1874, a fact is stated in regard to the natural history of the cod-fish which seems to require confirmation. According to this account, the cod-fish is, as may be supposed, the most important element in the fisheries, and those taken at the beginning of the year are said to be large and fat; and the time is also better fitted for drying them than at other seasons, as the air is then pure and cold. Their average weight when taken, after the head, entrails, and backbone are removed, is from twelve to thirty pounds. The cod is also very good during the months of March and April, but after this it becomes poor. It enters the harbors in May for the purpose of spawning, and is taken in great numbers in the summer. Cod, however, which remain in the open sea, on the Banks, are good throughout the year. The point of inquiry is as to the spawning of the cod in May, as Steenstrup has shown that on the coast of Norway they spawn in the winter season.—*Revue Maritime et Coloniale, March*, 1874, 762.

SOFTNESS OF BONES IN OLD CONGERS.

M. Camille Dareste (*Comptes Rendus Acad. Sc.*, Nov. 3, 1874) has confirmed in quite a number of individuals the fact that conger-eels not infrequently attain full size without

a complete ossification of the bones, the skeleton remaining in a more or less cartilaginous state.

LEPTOCEPHALI ARE LARVAL FORMS OF CONGERS, ETC.

Some years ago Dr. Theodore Gill pointed out, what had not previously been even suspected, that the remarkable transparent and elongated ribbon-like fishes, attaining a length of several inches, and known as *Leptocephali*, were really immature or larval forms of congers and related types. This discovery, although received with some skepticism for a short time, has been since universally recognized by European and other naturalists. The observations of M. Dareste may be co-ordinated with the previous ones, and find an explanation for the *raison d'être* in occasional persistence to a still more advanced stage or throughout life of some characteristics which are normally in these forms protracted through a considerable term of the early life of the fish. While the incompleteness of ossification is persistent, however, the form and most other characteristics of the normal adult congers are attained, the only other known arrest of development affecting the teeth, which do not attain the customary size.

HAVE JELLY-FISHES A NERVOUS SYSTEM?

The umbrella-shaped jelly-like organisms known as jelly-fishes, or acalephs, which are almost always to be seen floating near the surface of the sea, are, next to the so-called Protozoans, the simplest forms of animal life, and the existence of a nervous system has been regarded as extremely problematical, and, indeed, denied by most authors. At the base of the tentacles, which originate at equal distances from the margins of the umbrella-like disk, or "rectocalyx," however, there are minute vesicular-like bodies (called marginal vesicles), which have been supposed by some zoologists (*e.g.*, Agassiz, M'Crady, and Fritz Müller) to be the rudiments of a nervous system. This supposition has received much support, recently, from vivisectional experiments made by Mr. George J. Romanes. Mr. Romanes's observations were made on the acaleph known as *Slabberia conica*, a species about as large as an acorn, and, as the specific name implies, having a conic rectocalyx, from whose margin four tentacles originate; at the bases of these tentacles are vesicles smaller than the dot

which surmounts this *i*; small as these are, however, they appear to be so important to the animal economy that their excision paralyzes and renders inert the segment from which they are abstracted, and yet, although all that may be isolated from them is deprived of motility, the portions left connected with them preserve that function; thus, all but the margin may be cut away, and all such exsection will be rendered inactive, but the margin itself, retaining these vesicles, will still manifest, for an indefinite length of time, its contractile powers. Some of these facts (*e. g.*, the paralysis of the rectocalyx deprived of its margin) have been known before, but have been explained by the hypothesis that the severance of all the contractile fibres produces a kind of mechanical paralysis, analogous, for example, to disability to use the arms if all the muscles were divided. This explanation does not entirely account for all the manifestations exhibited in the experiments in question, and there is at least a strong probability that the minute dots referred to have a true nervous function.

SCUDDER ON THE BUTTERFLIES OF THE GENUS PAMPHILA.

A paper has just been published by Mr. Samuel H. Scudder, in the Memoirs of the Boston Natural History Society, on the butterflies of the genus *Pamphila*, in which, after a critical comparison of American and European forms, he comes to the conclusion that, after all, there is no difficulty in distinguishing the common species of Europe from its nearest American relatives. Of American forms he describes eight species, three of them in this work for the first time.

HABITS OF BEES, WASPS, AND ANTS.

Sir John Lubbock has recently presented to the Linnæan Society of London some very interesting notes on the habits of bees, wasps, and ants, drawn from his personal observation. The results seem to negative the idea popularly entertained that bees have the power of communicating intelligence from one to another; also that the working bees have any affection for one another, or for the queen bee independently of the utility of the latter for producing new broods. Bees have a decided taste in color, distinctly preferring blue to orange. Wasps are (Dr. Watts notwithstanding) of more

industrious habits than bees, performing a larger number of journeys in the same time. Ants appear to possess a distinct power of communicating with one another, but different individuals vary greatly in this respect.

OCCURRENCE OF A COCHINEAL INSECT IN NEBRASKA.

Mr. Austin, in *Psyche*, calls attention to the occurrence of a cochineal insect, in great abundance, on several species of the cactus growing in the northwest of Nebraska and adjacent portions of Dakota. He can find no evidence that the Indians were acquainted with the existence of this substance in its practical applications as a paint; and, indeed, the fact of its occurrence there at all was unexpected by him, although he has since learned that it is not uncommon in Kansas and Southern California.—*Psyche, Dec.*, 1874, 30.

MINERAL SUBSTANCES IN THE ARTICULATA.

E. Häckel gives the result of a series of experiments upon the localization, or heaping up, so to speak, of various mineral substances in the articulata, and its physiological results, referring more particularly to the administration to various species, especially cockroaches and crabs, of a diet consisting of metallic arsenic and flour. After feeding with this substance for forty days the animals were dissected, and arsenic found in the cœca of the stomach, as also in the Malpighian tubes, in the latter the indication being most decided.—6 *B*, *August* 24, 1874, 513.

CAPTURE OF INSECTS BY "FLY-CATCHING" PLANTS.

Much attention has lately been attracted to the so-called fly-catching plants, and the object of the various provisions by which the capture of insects is rendered possible, whether, as in the Venus fly-trap (*Dionæa muscipula*), by the bringing together of two laminæ of a leaf, with a row of spines around the margin, or by attracting them into a cup-shaped receptacle, as in *Nepenthes* and *Sarracenia*, or by the presence of organs secreting a viscid juice, as in *Drosera*, or sundew, which holds an insect whenever it alights upon the surface. Professor Bailey, of Providence, has lately called attention to a similar function of the latter nature in the *Azalea viscosa*, or swamp honeysuckle, which has its corolla

covered with innumerable clammy and glandulous hairs. In the bud these hairs appear to cover the whole surface of the flower, but when the corolla expands they seem to occupy the midrib of the petals as well as the tube of the corolla. These glandular hairs are efficacious fly-catchers, but what is their precise object, or the method of application, Professor Bailey is at present unable to indicate.—5 *D, September*, 1874, 517.

GIANT CUTTLE-FISH FOUND ON THE GRAND BANK, DECEMBER, 1874.

Some time since the discovery was announced by the Rev. Mr. Harvey, of St. Johns, Newfoundland, of a giant cuttle-fish off the coast of that island. We now learn from him that a still larger one was cast ashore on the Grand Bank, near Fortune Bay, in December last. The larger arms measured twenty-six feet each, with a circumference of sixteen inches, the short arms being about one third that length with the same circumference. The total length of the body was fourteen feet. No portion was preserved excepting the beak and one sucker, which is an inch in diameter. The fishermen carried it off as food for their dogs. The specimens preserved will probably be sent to Professor Verrill, of Yale College, for comparison with what he has of the first one.

FAUNA OF THE CASPIAN.

Professor Oskar Grimm has lately published an account of the investigations made, under the direction of the Society of Natural History of St. Petersburg, upon the fauna of the Caspian Sea. The results of these had been extremely interesting and rich, no less than eighty new species having been discovered, and the total number known raised to 150.

According to Professor Grimm, the Caspian appears as a large, half-salt sea, possessing partly its own animal forms and partly such as occur in other seas, the former being descended from species still living or already extinct, or slightly changed from foreign related species in other waters. The species which occur in other seas are forms which possess great tenacity of life, as they still manage to sustain existence, their former associates of less hardiness having died out.

The faunal affinities of the Caspian are with the Sea of

Aral, the Black Sea, and the Northern Ocean, but those with the Arctic Ocean are more recent than with the Black Sea, in which the seal, the coregonus, and other species common to the Caspian and the Arctic Ocean do not exist. It has been inferred from the phenomena observed that in the tertiary period there was a large but closed fresh-water basin in Europe and Western Asia, which, by volcanic elevation of the earth's crust, was divided into several smaller basins, such as the Black Sea and Aral-Caspian. At that time the water of the Arctic Ocean broke into the Caspian, and having still a connection with the Black Sea, though a slight one, a few animals, and only a few, reached the sea from the latter.

The Caspian, however, according to Professor Grimm, not only received species from the Arctic Ocean, but has also furnished some to it, especially the sterlet (*Acipenser ruthenus*). As a general rule, in the Caspian Sea the abundance of individuals replaces the abundance of species, and many of the mollusks described by Eichwald as sub-fossil were found living, and not smaller than their extinct relatives. The deepest parts of the sea were inhabited most abundantly, and by quite different species from those at the depth of only a few fathoms. In Professor Grimm's opinion, the Oxus of the ancients at one period unquestionably flowed into the Caspian Sea.—18 *A*, *September* 3, 1875, 626.

GIGANTIC MARINE WORM.

Dr. Carl Möbius, an eminent German zoologist, of Kiel, has been engaged for some time in the exploration of the Mauritius and of the waters adjacent; and according to a letter received by Captain Nicholas Pike, of New York, from Edward Newton, Dr. Möbius has lately discovered a marine worm 300 yards in length!

DOMESTICATED ANIMALS AMONG THE ANCIENTS.

It is an interesting fact in the history of the domestication of animals among the ancients, that the Egyptians bred several species, and kept them in large numbers, which are not now employed in any part of the world. Among these are the Addax and Beisa antelopes, the gazelle, or Dorcas antelope, and the Kobe antelope. The evidence of this is found, together with much else connected with the history of the

ancient Egyptians, in the pictures on the tombs, where flocks of these animals are represented with others receiving the attentions of the farmer and herdsman. From about 1800 years before the Christian era, however, these representations were fewer and fewer in number, and after that time their occurrence in relation to domestic animals seems to have ceased.

CHANGE OF COLOR IN THE CHAMELEON.

M. Paul Bert has exhibited, at a meeting of the Biological Society of Paris, a series of experiments on the coloration of the chameleons, bearing especially upon the changes of color produced if one or both eyes be extirpated. If a single eye be removed, the animal does not exhibit any change of color on the wounded side. If the light be brought to it, a very slow change of color takes place, and subsequently in that of the uninjured side. If both eyes be cut, a change of color on the two sides occurs under the influence of fierce excitements.

It has been previously ascertained by M. Bert that, on removing the right hemisphere of the brain of the chameleon, the animal only made use of the members of the left side, and after taking away the left hemisphere, then it could use the members of both sides.

This phenomenon seemed to indicate that to the chameleon is given in a measure a double being—that is to say, that the voluntary movements seem to recognize two centres, corresponding each to movement, coloration, and to sensations of the analogous side.—8 *B*, *September* 14, 168.

EXTINCT ANIMALS IN RODRIGUEZ.

It is well known that Rodriguez, the Mauritius, and other islands off the eastern coast of Africa, were at one time inhabited by various species of birds now entirely extinct, and known only by tradition, by the descriptions of several travelers, and by the occurrence of their bones in different localities.

The island of Rodriguez seems to have been much favored in this way, as mentioned by M. Leguat, who resided there from 1691 to 1693, and described species in his works that for a long time were supposed to be the figment of his own imagination, but which are now well established by osteo-

logical remains. The inquiry has been frequently made as to the precise period and the actual causes of this extinction, and Professor Alphonse Milne-Edwards has lately found a document which throws much light on the subject. This is a manuscript report in the Department of Marine, entitled "Relation de l'Isle Rodriguez," and is supposed to be of about the date of 1760.

According to this document, the birds continued quite abundant until about 1730, at which time, however, the settlement of the Isle of France and the Isle of Bourbon, together with the great number of vessels visiting the adjacent regions, made such depredations upon the living animals, especially the birds and tortoises, as soon to bring about their entire extinction. The birds were all restricted to narrow spaces, and being in large part unable to fly, fell victims to the weapons of the invaders. Indeed, so far as the tortoises were concerned, numerous vessels were employed exclusively in the business of collecting and shipping them.—1 *B*, *June* 20, 165.

FLIGHT OF BUTTERFLIES.

Mr. J. Matthew Jones gives an account of a very remarkable flight of small yellow butterflies, *Terias lisa*, of the family *Pieridæ*, which visited the Bermuda islands on the 1st of October, 1874. Their number was so great that their first appearance was that of a cloud coming in from the northwest, and when close to the land they separated into two columns, and dispersed east and west over the islands.

Mr. Jones does not consider that this was an intentional movement on the part of these butterflies, but that probably the individuals, while swarming at some point along the coast of the United States, were caught up in a cyclone or other storm, and carried out to sea to a great distance.

INTRODUCTION OF THE AMERICAN TURKEY.

The precise date at which the American turkey was introduced (probably from Mexico) into Europe has always been a matter of some uncertainty, its arrival in France having been ascribed to the action of the Jesuits. It took a conspicuous part in the nuptial feast of Charles IX., in 1570. A much earlier mention of this bird has, however, been found

in a manuscript recently printed in France, where in Gouberville's diary, under date of December 27, 1555, he speaks of having had brought to him an Indian cock and hen. Probably the bird must have been known for some time, from this casual mention, as the same journal contains notices in detail of new forms of animal and vegetable life which had attracted his attention.—10 *B*, *June* 3, 60.

STONE ARROW IN A HUMAN TIBIA.

Baudrimont gives an account of a human tibia found in Aveyron which had a stone arrow-head inserted in it, and which had remained adherent, and had caused a considerable exostosis of the bone. But what is most remarkable is the fact that the arrow-head was inserted by its haft and not by its point, there being no indication of any perforation. For this reason Baudrimont is of the opinion that the wound had not been produced in actual warfare, but that in all probability this was a case of surgical manipulation with the object of producing some specific effect, either moral or physical, similar in this respect to the system of trepanning on the living subject, of which several very striking instances have been brought to the notice of archæologists.—20 *B*, 1875.

INFLUENCE OF TEMPERATURE ON NERVOUS SENSIBILITY.

At a recent meeting of the Russian Scientific Association, at Kasan, some results were given by Troitzky of observations made by himself to determine the velocity of propagation of the excitement produced in the nerves of frogs, by galvanic currents of various degrees of intensity and of various temperatures. He found that for feeble currents the maximum velocity of nervous sensations is between the temperatures +20° and +10° C. The velocity diminishes when the nerves are warmed to 30° or cooled to zero. In stronger electric currents the influence of temperature upon velocity diminishes, the velocity being affected more by the strength of the current than by the temperature. In the case of very strong currents the influence of temperature entirely disappears. The velocity of transmission in the nerves depends upon the strength of the excitement, increasing directly as the latter.—19 *C*, VII., 204.

ARTIFICIAL DEFORMATION OF THE TEETH.

At the meeting of the Anthropological Society of Göttingen, July 17, 1875, Dr. Von Jhering, after a brief mention of practices common among people widely separated, especially their barbarous toilet operations, gave a minute description of deformations of the teeth. These practices are of three kinds: 1. Coloring the teeth with red and black dyes (Borneo and Burma). 2. Knocking out one or more incisors of the upper or the under jaw by some tribes of Australia and of Central Africa. 3. Disfiguring the teeth without removing them. Many tribes of Central Africa chip the incisors with the chisel so as to make them pointed, sometimes in the centre, sometimes on one, sometimes on both sides. In the latter case they are bicuspidate. In the islands of the Malayan Archipelago the aborigines practice the filing down of their teeth, already discolored by the chewing of betel, in two typical fashions: 1. Removal of the enamel from the whole front surface of the crown by horizontal strokes of the file, and by smoothing down the edge—a species of mutilation characteristic of the Malays of the East Indian Archipelago. 2. A removal of the enamel in triangular pieces so as to leave the tooth pointed, and the remaining enamel rhomboidal in form. This is practiced in Java, Bali, Madura, and Celebes, and is not known elsewhere, so that Virchow, A. B. Meyer, and others believe it to be an exclusive mark of these islands. Dr. Von Jhering has observed this mark upon crania in various collections, but they have always proved to be from one of these four islands. We must therefore conclude that this species of mutilation had its origin there, although we have not the least suspicion to which people it belonged, or whether it was a mark of noble birth.

COMPARATIVELY SMALL BRAIN IN EXTINCT ANIMALS.

The study of the form of the brain in extinct animals is one of much interest, and has been prosecuted with considerable success lately. Some years ago Professor Lartet, of Paris, pointed out the small size of the brain in Eocene mammalia as compared with those of the present time. Professor Gervais has described the characters presented by the skull-cast in *Toxodon*—a remarkable and gigantic ani-

mal, whose remains have been found in the post-Tertiary beds of Buenos Ayres. His observations led him to coincide with the view of Owen—that *Toxodon* represents a distinct order of mammals. Professor Cope recently pointed out the small size of the brain in Symborodon, from the Miocene strata of the Plains, showing that the greater part of the skull was occupied by immense air-chambers. Professor Marsh, of Yale College, has since compared the brain cavities of various genera of the American Eocene and Pliocene periods with existing forms, and finds those of the first-named epoch to be exceedingly small, and that there is a steady increase in size in the subsequent periods. Thus the brain in the gigantic *Uintatherium*, of the Eocene, is little larger than that of some reptiles. In the lines of the rhinoceros, tapir, and horse a regular increase in size from such beginnings can be traced.

DIMORPHISM IN CERTAIN BUTTERFLIES.

Some species of butterflies of the well-known genus *Grapta* have been found by Mr. W. H. Edwards to be dimorphic forms. By the simple experiment of tying up a *Grapta dryas* in a bag at the end of a branch of its food-plant, it laid a batch of eggs from which resulted a large number of *G. comma* and six *G. dryas*. He now gives in the *Canadian Entomologist* the results of an experiment made with *Grapta comma*, the converse of that made in 1873 with *dryas*. On the 10th of May last he took a female, true *comma*, and tied it up to a branch of hop-vine. She laid in the bag some forty eggs, from which hatched thirty-nine caterpillars. Most of them in due time reached the chrysalis state; and between the 10th and 15th of June there emerged thirty-four butterflies, every one a *Dryas*.

ANOTHER LINK CONNECTING BIRDS AND REPTILES.

One of the most important papers read at the Hartford Meeting of the American Association for the Advancement of Science was presented by Professor E. S. Morse. In it he points out an additional link connecting the birds and reptiles. The astralagus (one of the bones of the ankle) co-ossifies early with the end of the tibia, and this "process," as it has been erroneously called, ascends as a spur from the upper side of the astralagus in front of the tibia. In certain ex-

tinct reptiles—like *Hypsilophodon*, *Lælaps*, and others—the ascending process of the astralagus shows itself as an avian character. A few years ago Professor Wyman discovered that this process had an independent centre of ossification, and therefore could not be a process of the bone. Mr. Morse had interpreted this bone as the "intermedium" of Gegenbaur. The intermedium is a tarsal bone, occupying a position between the astralagus and the calcaneum. In the saurians, turtles, and other reptiles this bone is well seen. In certain amphibians, as in the salamanders, the bone is long, wedge-shaped, and partially projects between the tibia and fibula. Mr. Morse has expressed his belief that the ascending process of the astralagus represented the intermedium of reptiles. He had published in the "Annals of the New York Lyceum of Natural History" a theoretic figure of the proper position of this bone in birds, comparing it with the intermedium of certain salamanders. He explained its position in front of the tibia as a supposed process of the astralagus, calling attention to the excessive tendency to anchylosis in birds. The widening of the tibia to include all the tarsals within its width necessarily brings the intermedium in front of the tibia, and, as it early unites with the astralagus, has naturally been mistaken. Mr. Morse has been able to confirm his opinion regarding the nature of this bone in studying the embryos of common tern at the Anderson School of Natural History, at Penikese Island. In the embryo bird the intermedium showed as a long oval bone, the astralagus and calcaneum passing up between the tibia and fibula, as seen in the lower reptiles.

In this connection it is interesting to observe that in the mammalia the intermedium does not occur, and Gegenbaur has expressed the opinion that the astralagus and intermedium united. These investigations might possibly go to confirm that opinion by the fact that in reptiles the intermedium is separate; in birds it is separate in the young bird, but connected with the astralagus in the adult state; while in mammals, if Gegenbaur is right, it is always so connected.

SEX IN THE EMBRYO.

Mr. E. Van Beneden publishes in Gervais's *Journal* a paper on the original distinction of the testicle and the ovary, in

which he states that among the *Hydractinia* the eggs are developed exclusively at the expense of the epithelial cells of the endoderm, and remain up to the period of their maturity surrounded by the elements of the endoderm. On the other hand, the testicle and the spermatozoa are developed at the expense of the ectoderm, the organ resulting from a progressive transformation of the cellular fold, and originally formed by invagination.

He finds also that in the female spore-sacs there is the rudiment of a testicle organ, and in the male sacs a rudiment of the ovary. The spore-sacs, therefore, in his opinion are hermaphrodite. The endoderm and ectoderm have therefore opposite significations.—14 *B*, 1874, 450.

THE PALOLO WORM.

Among the most remarkable zoological phenomena of the Pacific Ocean may be mentioned the periodical annual occurrence at a regular date, in immense numbers, of a marine worm known as the palolo (*Palola viridis*), which appears in immense numbers in the vicinity of Samoa regularly at the time of the moon's last quarter in October or November. Its occurrence is eagerly looked for by the natives, who collect it in enormous amount and devour it greedily, both in a fresh state and also prepared in such a manner as to keep it for some time. From a paper by Mr. Whitmee, in the Proceedings of the Zoological Society of London for 1875, we learn that the two sexes are of different colors, and thus readily distinguishable, and that both males and females break up into a great number of small fragments, from which the eggs and the milt escape, so as to produce the necessary fertilization. Some idea of the abundance of this worm at the season in question may be gathered from the fact that the sea becomes quite of a milky appearance during this operation.—*Proc. Zool. Soc., London*, 1874.

OCCURRENCE OF MOA IN NEW ZEALAND.

Dr. Hector, at the recent meeting of the British Association, gave a very interesting account of the occurrence of moa bones in New Zealand, under this name including the various species of fossil giant birds, whether of the dinornis, harpagornis, or others. These remains are sometimes found

on the surface, sometimes in caves; generally, however, in the open and low scrub, and not in the region occupied now or formerly by the primeval forests. In the subalpine portion of the south of New Zealand, covered only with a slight vegetation, large quantities of well-preserved moa remains have been recently found, associated with relics of the natives, proving still more conclusively than heretofore that they served as food to the inhabitants, and that they were a favorite object of pursuit.

The occurrence of large numbers of the bones together is thought to be due to the fact that the animals were crowded by the firing of the brush by the Maoris. They are also discovered in the swamps and peat bogs in almost all the valleys leading to the coast. One of these was at Glenmark, where the remains of a terrace, at a higher level, had been cut through by a stream, leaving a large deposit on the shoulders of the hills on both sides. Here great numbers of bones were found without any Maori implements, indicating as many as 1700 individuals that had either been carried down and smothered in the floods or had died naturally and been carried down by the water. Similar deposits occurred in caves and in bogs on the coast exposed below high-water mark, showing that there had been comparatively modern submersion; but there were no marine deposits above.

These bones were also found wherever the country was favorable for the Maori camps, on the sheltered grassy plots, or among the neighboring sand-hills. Here they were associated with the cooking hollows and with stone implements similar to those now used by the aborigines.

In caves the moa bones were found resting on the stalactitic shelves, and probably came there by falling through the upper chasms, or by being washed in by the water, as is now the case with the remains of the sheep. The earliest traces of the moa bones were at Poverty Bay, in the form of footmarks, in a soft pumice sandstone six or eight inches from the surface. Dr. Hector does not consider the moa to be of the tertiary age, the supposed bones from such deposits, in his opinion, belonging to a gigantic extinct penguin.

H. BOTANY.

RELATION BETWEEN THE MODERN AND TERTIARY FLORAS.

A communication was made to the Vienna Academy by Ettingshausen, embodying his extensive researches on tertiary plant-fossils and their study in connection with modern floras. Regarding the present vegetable world as the result of a former preparatory condition, he proceeds upon the fact that the modern floras were already prefigured in the tertiary flora, not confined, however, as at present, to different distinct regions; but that plants, at present denizens of widely different portions of the earth, then flourished in the same region. The state of preservation of the fossils of temperate and subtropical plants, often occurring even in the same piece of rock, renders this fact inexplicable on the hypothesis of the mingling of the floras of mountains and lowlands, and leaves only the conclusion that these plants flourished in immediate proximity. Hence the tertiary flora, in comparison with the modern, may be regarded as a kind of compounded primitive flora, which by resolving, as it were, into its elements, produced the present natural floras, each of which consists of a principal element, and to a greater or less degree of secondary elements; the term "element" being understood to include all geological plant-forms, the analogues of which at present belong exclusively to the region of one natural flora. The tertiary flora, therefore, as it involved all modern floras, was, so far, of the same character over the whole earth. In the present flora then, regarded as the more fully developed tertiary flora, there are of course plant-forms on which the impress of the original elements may be recognized, although somewhat altered. This is very evident in regard to the principal elements, but the effect of secondary elements in the development of modern plants can also be inferred from the relationship of many modern genera and species, as well as from their distribution; and components of the natural floras, which do not seem to conform to the character of the same, clearly betray their association with components of the secondary elements; and the more or less extensive

groups of apparently exotic plants that are met with are only to be explained as the residue of secondary elements. Examples of the extent to which the composite character of the tertiary flora has still been retained are found in Japan, the southern portions of North America, and California, where plants related to those of almost all other regions occur. He sums up his conclusions as follows: 1. The natural floras of the world are allied to each other by the elements of the tertiary flora. 2. The character of a natural flora is determined by the predominant devèlopment of one floral element (the principal element). 3. Secondary elements have also affected the composition of modern floras, according to climatic conditions. The intermixture of members of the vegetable kingdom, apparently foreign to the character of the flora, produced in this way, sometimes appears only subordinate, but at others is of such an extent that it decidedly affects the character of the flora. 4. The species replacing each other in the regions of the different modern floras are corresponding members of similar elements.—19 *C, November* 14, 1874, 429.

CATALOGUE OF THE FLORA OF NEBRASKA.

A catalogue of the flora of Nebraska, by Professor Samuel Aughey, has been published by the University of Nebraska, with special reference to making exchanges of specimens. The general arrangement corresponds to that of Professor Gray, in his botanical works, and includes 2034 species as having been actually observed. Professor Aughey remarks that many of the native species along the eastern border of the state are rapidly disappearing, and others taking their place. Thus eight years ago the "silver-weed," *Potentilla anserina*, was common along the Missouri from Omaha to Dakota City, but is now rarely met with. He thinks, therefore, that the present condition of the flora of Nebraska should be put on record, so as to mark with greater accuracy the changes that may take place from year to year.

VEGETATION OF AMSTERDAM AND ST. PAUL'S ISLANDS.

It is a curious fact that the little island of Amsterdam, in the South Indian Ocean, is known to be covered with trees, while that of St. Paul's, only fifty miles to the south, is des-

titute of a shrub. Botanists have long been anxious to determine the character of the Amsterdam forest, but the difficulty of effecting a landing on the island has generally prevented the collection of specimens. In the last part of the journal of the Linnæan Society, Dr. Hooker announces that at length he has received the desired specimens, these having been collected by Commodore Goodenough, who states that they represent the only species of tree growing on the island. Dr. Hooker identifies this with the *Phylica arborea* of Thouars, a tree which, strangely enough, is found in the remote island of Tristan d'Acunha. It is a problem for those who study insular floras to suggest how the same plant can have established itself on these two little specks of land separated from each other by about five thousand miles of ocean.

LIST OF NORTH AMERICAN ALGÆ.

About twenty years ago the Smithsonian Institution published an elaborate work, by Professor William H. Harvey, of Dublin, upon the algæ or sea-weeds of North America, a subject which has always been of popular interest, as nearly all persons who visit the sea-shore are attracted by the beauty of the floating weeds, and are induced to make collections for preservation. The publication of this work gave a renewed impetus to the study, and at the present time there are many collections in the United States, both public and private, the determinations of all being based upon the work referred to. No systematic effort, however, has been made to bring the subject up to date, although Professor D. C. Eaton, of New Haven, and Professor W. G. Farlow, of Cambridge, have been engaged in investigations looking toward a revision of the group. Professor Farlow has, however, just published in the proceedings of the American Academy of Arts and Sciences of Boston a new list of the species, 430 in number, and embracing about 54 additions.—*Proc. Amer. Acad.*, 1875, 351.

BOTANY OF THE LIBYAN DESERT.

The Swedish botanist, Ascherson, has recently been exploring the flora of the Libyan Desert, having been attached for this purpose to the expedition of Rohlfs. Thirty-three species, belonging to 14 different families, were met with in the desert proper (*e. g.*, at least an hour's journey from any of the

oases or wells), the best represented orders being the Cruciferæ, Zygophylleæ, Leguminosæ, Compositæ, Borraginace, Chenopodiaceæ, and Gramineæ. In the oases, 92 species were found in Farafreh, 189 in Dghakel, and 225 in Khargeh, besides a number of cultivated plants; but many of the former had evidently been accidentally introduced. Very few of the species were new, and these were nearly related to species already known.

MAXIMUM AND MINIMUM TEMPERATURE AT WHICH CERTAIN SEEDS WILL GERMINATE.

Hoberlandt has lately published a table showing the maximum and minimum temperature at which a large number of agricultural seeds will germinate. From this it appears that the minimum of the largest number, including wheat, barley, rye, oats, buckwheat, sugar beet, linseed, poppy, clover, pease, mustard, etc., is about 40.55° Fahr. The minimum for carrots, sunflower, sorghum, and maize lies between 40.55° Fahr. and 50.90° Fahr. For tobacco and the gourd it is between 50.90° Fahr. and 60.12° Fahr. For cucumber and melon it is between 60.12° Fahr. and 65.30° Fahr.—21 *A, Sept.*, 1874, 910.

ASSISTING THE GERMINATION OF SEEDS.

According to Böttger, a moderately concentrated solution of caustic soda or potash seems to promote the germination of seeds even more than ammonia, especially of coffee beans, which germinate with difficulty. After soaking a few hours in dilute potash solution, they often put forth snow-white radicles.—14 *C*, CCXIII., 1874, 444.

FOSSIL FLORA OF THE WESTERN TERRITORIES.

Under the title of "Contributions to the Fossil Flora of the Western Territories: Part I. The Cretaceous Flora, by Professor Lesquereux," Professor Hayden has published the sixth volume of the series of final reports of the United States Geological Survey of the Territories. The work is in quarto, and embraces one hundred and thirty-six pages and thirty plates. Very many new species are figured and described. The name of the author is, of course, a sufficient guarantee of the scientific value of this work, which covers all the known species of the Dakota group, and constitutes an important

starting-point for similar monographs of other divisions of the fossil plants of America.

Professor Lesquereux gives an account of the circumstances under which this formation was discovered and explored by Dr. Hayden and others, and then considers the surface and stratigraphical distribution of the species. In accordance with Dr. Hayden's views, the author finds the group to be of marine origin, as shown by the occurrence of various species of marine mollusks.

Numerous important general considerations are presented by Professor Lesquereux in connection with his subject, and in the concluding part of the memoir he remarks that he is not prepared to commit himself in regard to the correlation of the flora of the Dakota group with that of subsequent geological epochs, and their identity, preferring to wait the gathering and examination of other series. He, however, states that this flora, without affinity with any preceding vegetable types, without relation to the flora of the lower tertiary of the United States, and with scarcely any forms referable to species known from coeval formations in Europe, presents, as a whole, a remarkable and, as yet, unexplained case of isolation.

ABSORPTION OF OXYGEN BY PLANTS IN THE DARK.

According to Dehérain, leaves kept in a confined atmosphere, in darkness, will absorb the whole of the oxygen, and still continue to give off carbonic acid, the resistance to asphyxia varying with the species. The rapidity of growth and energy of respiration of plants are both favored by obscure heat; and it is shown that the internal combustion, by the absorption of oxygen and emission of carbonic acid, is the origin of part of the heat necessary to the elaboration of new proximate principles in the plant.—21 *A*, *Sept.*, 1874, 910.

TRANSFER OF THE ALBUMINOIDS OF THE SEED INTO THE PLANTLET.

It is a familiar fact that germinating plants derive their nutrition from the reserve materials in the cotyledon, and that the insoluble starch of the latter is converted, in the process of germination, into soluble sugar, and, as such, transferred to the new plantlet. Some late German investigations

have thrown light upon the method of transfer of the albuminoids of the seed into the different parts of the new plant during the process of germination. Asparagin, first discovered in asparagus, seems in general to perform this task, in giving up, in the first place, in the respiration of the plant, a certain amount of carbonic acid and water, and is afterward united in the new plant to corresponding amounts of carbon and hydrogen, to form albuminoid materials again.

EFFECT OF CHLOROFORM ON VEGETABLE INFUSIONS.

Barnes has made a communication to the Pharmaceutical Society of Great Britain upon the preservative effect of chloroform on vegetable infusions, in which he shows that of all substances applicable to the purpose of preparing unchanged infusions for medical purposes chloroform is among the most valuable. In one case four grammes of chloroform were added to four fluid ounces of mucilage of tragacanth, and at the expiration of a month the mass was found to be perfectly neutral, while another portion, not treated with the chloroform, had become strongly acid and unfit for use.

It is equally serviceable in preventing the souring of paste and gum-arabic, its special property seeming to depend upon the power possessed by chloroform to prevent alcoholic fermentation. When mixed with yeast, even in a warm place, fermentation and the accompanying development of alcohol is prevented.

Barnes also found that by adding twenty minims of chloroform to eight fluid ounces of fresh milk, the milk remained fresh after the lapse of five days, though kept in a warm place. If the milk thus treated be boiled just before using, all the chloroform will be driven off. The same application has also been used in the preservation of concentrated infusions of quassia, colombo, gentian, etc.—14 *A*, *March* 5, 1875, 441.

EFFECT OF SOLUTIONS ON A GROWING VINE.

Baudrimont has been continuing his experiments on the influence upon the branches of a growing vine of immersion in water containing various substances in solution, and has obtained some rather remarkable results, by various poisonous agencies, some appearing actually to increase the vigor

of growth of the vine and prolong its existence, as in the case of chloride of potassium; while others cause the plant to wither, as in creosote and carbolic acid. Bromide and iodide of potassium seem to act in the same manner as chloride of potassium. Chloral hydrate exercises a very poisonous influence, destroying the branch vine in three days, the effect differing from that of carbolic acid. One of the most curious phenomena is that which is exhibited in the fall of the leaves. In some instances the petiole becomes detached at the point where it is inserted in the branch. This takes place with such substances as bi-chloride of mercury, and chloride, bromide, and iodide of potassium. In other cases it is the limb which separates from the extremity of the petiole. This occurs with ordinary water, and the nitrates of ammonia, potash, and soda. In one single instance both forms of observation have been observed under the influence of the same substance. Sometimes, again, the branch dies while the leaves continue to adhere to it. This is the case after the use of hydrocyanic acid and the essence of turpentine. Chloride of potassium acts as an invigorating and preserving agent, quite exceptional in its character. A current of ammonia allows the branch to preserve its freshness for eight days, after which it withers.—1 *B*, *Dec.* 20, 1874, 189.

HEAT AND VEGETATION.

In some remarks on the relation between heat and vegetation, which are translated by Firket from the work of Kabsch on the "Vegetation of the Earth," the latter states that the three fundamental laws of vegetation are as follows: First, for each plant there exists a maximum and a minimum temperature, between which this species is capable of normally exercising its vital functions; second, in the germination of grains, the opening of buds, the maturing of fruit, each has need of a certain average degree of temperature, which may be very different according to the species of plant; third, each species of vegetable, in order to go through the various phases of its existence, needs a certain sum total of heat, and it is only in the localities where this sum total is furnished every year, and where the conditions of humidity and the constitution of the soil are equally favorable, that the existence of the plant can be regarded as

assured. Applying these principles to certain well-known plants, Kabsch finds for the grape-vine, for instance, that the limiting temperatures between which the vine can be cultivated naturally are minus 19° C. and plus 20° C. The average degree of temperature must be plus 8° C.; the sum total throughout the year must be 2900°.—*La Chaleur*, *Ghent*, 1873, 46.

HEAT AND VEGETATION.

Morren, of Liege, has presented his views on the relation of heat to vegetation, especially as to the dynamic influence of heat on the growth of plants. He says that we will elucidate this matter slowly, in proportion as physics and chemistry make progress in the revelation of the nature of bodies and forces. Heat has an influence upon the growth of plants, on the circulation of the sap, elaboration of the cells, the respiration, and many other phenomena. The relation of heat to the development of plants, and particularly the periodic phases of vegetation, are phenomena known through the epoch at which they manifest themselves, the mean dates of these manifestations, and the average deviations therefrom.

After giving an abstract of the results of the labors of Schubeler, Hofmann, Fritsch, Linnsser, and Kabsch, Professor Morren states that a problem of high importance, and one which has been, perhaps, too much neglected, is that of the relation between heat and the weight acquired by the plant under the action of the solar rays, and especially its relations to the quantity of carbon fixed in the organic matter, as far as we can at present estimate that. In a temperate climate a hectare of forest and prairie, or cultivated land, fixes in one year from 1500 to 6000 kilogrammes of carbon; and in order to accomplish this work vegetable organisms utilize between one and four thousandths of the heat which has been received by solar radiation upon the surface that they occupied. It is evident that such phenomena as take place periodically, viz., germination, leafing, etc., are acts of growth; such growth supposes movement; the fact of the movement necessitates consumption of force, which consumption is but a transformation of heat. If, to fix our ideas, we suppose an apple to fall from a tree, we have but to reflect upon the laws of force in order to see that the apple must

have been previously carried up into the tree, for it evidently has not raised itself there. It is the power of the heat proceeding from the sun which has effected the development and growth of the tree. It is, therefore, practicable to determine the mechanical coefficient of growth, as Sausom has determined the mechanical coefficient of nourishment for foods. It is the property of vegetable organisms to utilize the heat received by them from any source, for the conversion of crude material into such forms as are needed by them for their own growth. In this process, however, force is neither created nor lost, although much of it is secreted within the body of the plant or mineral. Other things being equal, the quantity of carbon fixed in any plant varies with the average elevation of the height of its centre of gravity.—*Morren, on the Energy of Vegetation, Brussels*, 1873.

THE RESPIRATION OF LEAVES IN THE DARK.

An important paper by Dehérain and Moissan upon the respiration of leaves in the dark has lately been published in *Comptes Rendus.* Among the more important conclusions reached by the authors in their researches are: First, that the quantity of carbonic acid which is thrown off by leaves in the dark increases with the increase of temperature; second, that the quantity of carbonic acid thrown off is comparable to that yielded by the cold-blooded animals; third, that leaves kept in the dark absorb more oxygen than they throw off carbonic acid; fourth, that leaves continue to throw out carbonic acid in an atmosphere deprived of oxygen.

The authors present the following hypothesis upon the physiological uses of this internal combustion which takes place in the leaves, as the result of their numerous experiments. The immediate constituents which are necessary to the growth of the plants, and to the formation of new organs, are in part formed in the leaves. This growth is especially favored by warmth in the dark, as a principle well known to gardeners who cover plants, the development of which they wish to accelerate, under glass, in which case a part of the light necessary for the composition of the carbonic acid is reflected, but an elevated temperature is se-

cured. This heat in the dark is especially favorable to an active respiration, as we find that the quantity of carbonic acid increases in proportion to the increase of temperature in the leaf, so that there seems to be a relation between the rapidity of growth and the energy of respiration.

This can easily be appreciated when we assume that a certain portion of the heat must enter into action in order to the formation of the immediate principles. The internal combustion, which is indicated by the absorption of oxygen and the throwing off of carbonic acid, is probably the source of the heat necessary for the formation of the new immediate constituents.—19 *C, June* 20, 1874, 235.

IODINE AND BROMINE IN FRESH-WATER PLANTS.

Zenger states that Petter detected iodine in the ash of the *Cladophora glomerata* in 1862, and that Jessler subsequently determined the amount to be 0.2343 grains in 9960 grains of the dried algæ. According to his own analyses, the ash of the plant amounts to 52.85 per cent., and 56,000 grains of ash contain 21.5 grains of iodine and 8.5 grains of bromine. The large amount of ash consists mainly of lime. He concludes from his own experience that iodine and bromine are present in much larger quantity than is suspected in fresh-water plants, and that they are also present in land plants, and suggests that fresh-water plants, by reason of their wide distribution, may become an important source of these elements. His most recent investigations of the aquatic plant *Lemna minor* show the presence of a large amount of iodine, and also of bromine.—18 *C, April* 14, 1875, 229.

ORGANIC SUBSTANCE IN THE PLANT.

A résumé of the past progress and present condition of our knowledge of the production of organic substance in the plant is given, in the Prussian *Landwirthschaftliche Jahrbücher*, by Professor Pfeffer, of the University at Bonn. Professor Pfeffer concludes that the production of organic substance from inorganic materials is dependent upon the action of chlorophyl, and requires in connection with the coloring matter of the latter nitrogenous protoplasm. The first product is generally starch, occasionally sugar, still less

frequently fatty oil. The agency of light is requisite, the yellow rays being chiefly efficient. Many plants require but little light or but little warmth for assimilation. An increase of temperature above blood-heat is injurious or fatal, while an increase of light is only beneficial. The chief absorption of carbonic acid for assimilation is effected by the leaves, which give off oxygen in return. Another and more constant vital activity of the plant is slow combustion, with the giving off of carbonic acid; and this is noticeable only when the mass of assimilated carbonic acid sinks under that which is given off, as happens at night.

RESIN IN THE AGARIC.

It appears that the fungus known as the White Agaric (*Polyporus officinalis*) contains nearly sixty per cent. of resin, and it is suggested that this mushroom may advantageously be cultivated in large quantity on account of this ingredient.—18 *A, April* 23, 150.

OSTRUTHIN, A NEW VEGETABLE PRINCIPLE.

A new crystalline vegetable principle has been detected in the root of master-wort by Gorup-Besanez, to which he has given the name Ostruthin. It crystallizes in white needles or prisms, and contains no nitrogen.—21 *A*, *Sept.*, 1874, 907.

REVISION OF THE SUB-ORDER TULIPEÆ.

A revision of the sub-order *Tulipeæ*, by J. G. Baker, has recently appeared in the journal of the Linnæan Society of interest to American botanists. This group of six genera and one hundred and seventy-nine species is confined to the north temperate zone, having its largest development in Eastern Asia, but ranging largely on the one side to Europe and on the other to California and the Rocky Mountains. The tulip is the only genus not represented in America, the lily extending across the continent, and the fritillary stopping short at the Rocky Mountains. On the other hand, the calochortus, numbering twenty species or more, is limited to our more western territories. Of the half-dozen erythroniums, one is restricted to the Old World, the rest to the New. It is singular that a species in the smallest genus (*Lloydia serotina*) should be the one most widely distrib-

uted of all the lily tribe, and the only one that is really arctic or alpine.—*Jour. Linnæan Soc.*, XIV.

COPTINE.

A peculiar principle called coptine has been found by Gross in the *Coptis trifolia*, or golden-thread, of Europe and America. This is associated in the plant with berberine, but is distinguished by being colorless, and by yielding a crystalline precipitate with potassia-mercuric iodide.—21 *A*, *Sept.*, 1874, 912.

CHEMICAL COMPOSITION OF PLANTS.

Our knowledge of the chemical composition of plants used for food has been obtained for the most part from European analyses, which have, indeed, during the past two decades grown to be very numerous and complete. The most valuable tables of the composition of plants in use with us are of German origin. That these, in some cases at least, are not fully correct for American products is shown by some analyses lately made by Professor Storer. Samples of bog and meadow hay and other plants were found to contain only from 8 to 10 per cent. of moisture, and a sample of timothy hay yielded only 7.8 per cent. In the European analyses of different kinds of hay, 14 or 15 per cent. is generally given. Why hay in New England should contain only little over half as much water as in Europe is a matter worthy of investigation.

A BURIED FOREST IN ORWELL, ENGLAND.

Mr. J. E. Taylor, according to *Nature*, has discovered a buried forest in Orwell, England, represented by a layer of peat containing trunks, leaves, and fruit of the oak, elm, hazel, and fir, associated with the remains of mammoths. Mr. Taylor considers this forest to be contemporaneous with others along the coast which existed previous to the depression separating England from the Continent.—12 *A*, *Oct.* 29, 1874, 529.

DISTRIBUTION OF THE FERNS OF NORTH AMERICA.

Mr. John H. Redfield publishes in the *Bulletin* of the Torrey Botanical Club a paper upon the distribution of the ferns of North America, and arranges the species in six geographical

divisions. The first of these he calls the *Cosmopolitan*, which embraces two species (*Pteris aquilina* and *Asplenium trichomanes*), distributed over the globe in both temperate and tropical regions. *Pteris aquilina* lives in sandy barrens, and is found every where from Lapland in the North to New Zealand and Tasmania in the South, in America reaching from Labrador to Alaska and the Isthmus of Panama.

Species of the second, or *Boreal* division, occupy the northern part of the United States, extending through Canada and British America, some of them to Labrador, Greenland, and Alaska, and represented also in the northern sections of the Old World. Of these there are twenty-seven species.

In this group we find an illustration of what has been noted by Professor Gray in regard to flowering plants, namely, a much closer relation between the species of Western America and Eastern Asia than between those of Eastern America and Western Europe. Thus the *Asplenium septentrionale* is widely distributed in the mountains and colder portions of Europe and Asia, but is only known in this country in the Rocky Mountains as far south as latitude 32°.

Pelloea gracilis, an American form, occurs in the Old World only in the Himalaya Mountains.

Third, the *Appalachian* division. The species occupy the mountainous and hilly regions east of the Mississippi, often to the coast, and northward to Canada, in some few instances occurring also in the Old World. The number under this head amounts to about thirty-eight.

Fourth, the *Pacific* division, which contains species extending to the western borders of the continent, from Alaska to California, in a few cases appearing also in the Rocky Mountain region. Here we have seventeen species.

Fifth, the *New Mexican* division. Of this some of the species occur in Mexico, and even in South America; a few also in California. There are twenty-seven species enumerated under this head.

The sixth, or the *Tropical* division, includes twenty-two species inhabiting the borders of the Gulf of Mexico, most of them extending to the West Indies and tropical America. Of these, one, *Trichomanes petersii*, is quite local, having been found only in Alabama and Florida.

Of 125 species enumerated, sixty-nine, or about fifty-five

per cent., are found in the New World only, and of these sixty-nine about fifty-three, or over forty-two per cent. of the whole, are restricted to the limits above assigned. There remain seventy-two species which we share with other portions of the world. Of these forty are found in common with Europe, four of them not occurring elsewhere.

We have thirty species in common with the Himalayas of Northern India, of which two are not found elsewhere. With Northern or Eastern Asia we have thirty species in common, and, taking the whole extent of Northern and Eastern Asia, we have forty-six species in common out of the seventy-two, showing a very decided preponderance in Asiatic forms, as already referred to.—*Bull. Torrey Bot. Club, Jan.* 1, 1875.

THE BLADDERWORT A CARNIVOROUS PLANT.

Mrs. Mary Treat communicates to the New York *Tribune* of February 1 some original observations upon the bladderwort (*Utricularia*), and its functions as a carnivorous species, as in the case of *Sarracenia, Drosera*, etc. Bladderwort grows abundantly in shallow ponds and swamps throughout the Northern United States, and is characterized by the possession of numerous little bladders scattered among the leaves, which were supposed to be used in some way for floating the plant, especially during the flowering season.

Mrs. Treat, however, had her attention called in the first place to the fact that the bladder-bearing stems really sank lowest into the water, and the subsequent detection of minute microscopical animals in the interior induced her to examine the subject in reference to a possible animal diet. She has finally satisfied herself that the true function of these bladders is to entrap the various forms of animals, some of them larvæ, probably of dipterous insects and others, entomostraca, such as *Daphnia*, *Cyclops*, and *Cypris;* and that, once inside of the bladders, the latter constitute so many little stomachs for their convenient digestion.—*N. Y. Tribune, Feb.* 1, 1875.

NEW SPECIES OF GLAUCIUM.

In working over the refuse of the ancient silver-mines of Laurium, in Greece, for the purpose of extracting the remaining percentage of metal, a considerable amount of soil has

been uncovered, in which has appeared over a tract of 50,000 square meters a luxuriant growth of *Glaucium*, which is characterized as a new species under the name of *G. serpieri*, and is unknown elsewhere at the present time. It would appear from the indications that the seeds of this plant must have remained alive during the interval of 1500 or 2000 years which have elapsed since the mines were last worked. —13 *A, March* 29, 1875, 295.

STIMULATING ACTION OF CAMPHOR ON PLANTS.

Dr. Vogel, of Munich, has repeated the experiments made by others on the stimulating action of camphor upon the growth of plants. He concludes that, except in a few cases, we possess in camphor a stimulant capable of greatly increasing the luxuriance and rapidity of the growth of plants. Thus, when branches of seringa in flower were introduced into camphorated water, the drooping of the plant was entirely overcome, some blossoms being even developed under these circumstances. The seeds of *Lopidium sativum*, after having been kept dry for three years, were watered with camphorated water, and germinated with remarkable quickness; while the seeds of *Raphanus sativus major*, which had been dried for five years, and had refused to germinate in the garden, when treated with camphorated water germinated in four days. Similar interesting results have been obtained with other seeds. Some experiments made with the essence of terebinthine have shown that, while like camphor favoring the germinating process, the former arrests the ulterior development of the plant.—*Bull. Hebd.*, XVI., 46.

DARWIN ON INSECTIVOROUS PLANTS.

Mr. Darwin's new work on insectivorous plants has been a great success, 2250 copies of the English edition having been sold in a very short time. The most interesting and novel point which he brings out is the existence in *Drosera*, *Dionæa*, and some other plants which come under this designation, of an actual digestive fluid, which in the case of *Drosera* becomes acid only when the secreting glands are excited by the presence of nitrogenous matter, a substance being formed apparently closely analogous to the pepsin

contained in the gastric juice of animals. The excessively minute quantities of nitrogenous substance which cause inflection of a gland of *Drosera* are very astonishing—in the case of carbonate of ammonia about a twenty millionth of a grain.

INFLUENCE OF AMMONIA ON THE COLORS OF FLOWERS.

The Journal of the Central Horticultural Society of France gives some interesting details of the alterations which the natural colors of flowers are subjected to under the influence of ammonia. If we expose flowers originally of a violet hue to the fumes disengaged by a cigar, we see these flowers take a green tint more pronounced than was their proper color. This change is due to the ammonia in the tobacco smoke. Starting with this idea, the Italian Professor Gabben has made a series of experiments having in view the changes that ammonia brings about in the colors of different flowers. He simply made use of a plate containing a certain quantity of a solution of ammonia known commonly as volatile alkali. He shows that, under the influence of ammonia, blue, violet, and purple flowers become a beautiful green, red and carmine grow black, and white flowers turn yellow. The changes of color which are most singular are those shown by the flowers which have many different tints, out of which the red lines become green, the white yellow, etc. A remarkable example of this is seen in the fuchsias having white and red flowers, and which by the action of ammoniacal vapors become yellow, blue, and green. When the flowers have been subjected to the changes that color them, they will, if plunged in pure water, retain their new colors for many hours, after which they return to their primitive shade. Another interesting observation, due to Gabben, is that the flowers of the aster, which are naturally inodorous, acquire an agreeable aromatic perfume under the influence of ammonia. The flowers of these same asters, whose natural color is violet, become red when washed with diluted nitric acid.—1 *B*, XV., 42.

HOLLYHOCK FUNGUS.

The hollyhocks of Europe are threatened with destruction by the rapid development of a fungus known as *Puc-*

cinia malvacearum, and probably imported from Chili, where it was discovered on *Althæa officinalis*. It was first observed in the neighborhood of Bordeaux, France, in April, 1873, on *Malva sylvestris*, and extended rapidly to other plants of the same order in the botanic gardens of that town. It appeared in Germany in October, having been found in England in the preceding summer.—12 *A*, *April* 16, 1874, 470.

PROPOSED WORK ON AMERICAN FOREST TREES.

Dr. F. B. Hough, of Lowville, New York, well known in connection with his efforts looking toward the protecting of American forests from destruction, proposes, should he succeed in obtaining at least two hundred subscriptions, to publish a work which will be of much interest to botanists, microscopists, and workers in wood. This will consist of actual sections of two hundred species of American woods, properly mounted for examination under the microscope, and suitably labeled, to be accompanied by text containing descriptions of the species represented, of their qualities and uses, with other statistical information. The whole will form three small quarto volumes, and the specimens will be prepared by Professor Nördlinger, of Hohenheim, who has already been connected with similar publications relating to the forest trees of Europe.

A NEW WORK BY MR. DARWIN.

Mr. Darwin has lately published in England, under the title of "The Movements and Habits of Climbing Plants," a reprint of his paper on this subject printed some years ago in the Journal of the Linnæan Society of London, which first attracted public attention to the remarkable phenomena connected with the rotation of climbing stems and tendrils. A good deal of fresh matter is also inserted. Mr. Darwin's work on "Insectivorous Plants" has met with a large sale, being already in a third edition. Professor E. Morren, of Liege, has published in the *Bulletin de l'Académie Royale de Belgique* a record of a series of experiments which, while they abundantly confirm the insecticidal powers of the leaves of *Drosera* and *Pinguicula*, lead him to doubt the power of absorption and digestion assigned to them by Mr.

Darwin. MM. Reess and Will, on the other hand, in the *Botanische Zeitung*, abundantly confirm Mr. Darwin's results in the case of *Dionæa* and *Drosera*, as is also the case with two independent series of observations carried on in England by Dr. Lawson Tait and Mr. J. W. Clark. The former gentleman claims to have established the absorptive power of the leaves of *Drosera* by planting in perfectly pure silver sand plants from which the roots had been entirely removed, and feeding them with extract of beef and phosphate of ammonia; the latter by feeding the leaves with bodies of flies soaked in a solution of citrate of lithium, and then finding the lithium in other parts of the plant by means of the spectroscope.

FERTILIZATION OF A FERN.

Mr. H. H. Babcock has lately communicated an interesting fact in regard to a well-known fern, the *Aspidium acrostichoides*. In this plant, at the time of maturing of the spores, the elastic band of each *theca* slowly straightens out, carrying the spores in a mass at its tip. After straightening and bending back as far as possible, it gives a sudden forward spring, projecting the spores in a shower. It then gradually resumes its original position, and then the *theca* presents the appearance of having simply been ruptured to allow the spores to fall out.

NEW WORK ON MEDICINAL PLANTS.

A new work has been commenced in London, under the title of "Medicinal Plants," to contain colored plates included in the pharmacopœia of Great Britain, India, and the United States, together with descriptions of plants, their nomenclature, geographical distribution, etc., and an account of their properties and uses.

I. AGRICULTURE AND RURAL ECONOMY.

NOXIOUS EXHALATIONS FROM THE MEADOW-SAFFRON.

Isidore Pierre communicates to the Paris Academy an interesting fact in regard to certain exhalations from the flower of the *Colchicum autumnale*, or meadow-saffron. In passing through a garden where these plants were in full bloom he accidentally held his hand near the flower, and found, after a few seconds, that his fingers had changed color, and assumed a yellowish-green tint, similar to that of the decomposing human subject. In a short time, however, the skin resumed its natural color. The precise character of this emanation Pierre was unable to determine. It could not be any solid substance, as it would have been much more persistent. He thinks, therefore, it is some extremely volatile liquid, which he proposes to investigate hereafter. He is convinced, also, that exposure to it produced certain uncomfortable sensations both in his hand and his mouth, calling to mind the toxical effects of the meadow-saffron, which under certain circumstances, especially when fresh, is highly poisonous.—6 *B*, *September* 14, 1874, 635.

VARIOUS INSECT-POWDERS.

The very great extent to which the various insect-powders now before the world are used for the destruction of noxious insects is well understood at the present time, the apparent quackery of the recommendations of the insect-powders being now well substantiated by abundant experience. Although insect-powders have been in use from time immemorial in China, Tartary, Thibet, etc., especially in enabling the herdsmen of the steppes to exist in company with the countless myriads of gnats and mosquitoes (for which purpose the substance is burned inside of the tent), it was not until 1846 that Zachrel, a Tiflis merchant, first introduced it for sale in Vienna, under the name of "Persian Insect-Powder." This was originally derived from two plants, the *Pyrethrum carneum* and *P. roseum*, both growing wild in the Caucasus, and largely cultivated there. Since that time the manufact-

ure of insect-powder in Europe has increased wonderfully, and has been extensively introduced into America.

Quite recently a second variety of insect-powder has come into notice under the name of Dalmatian Insect-Powder, derived from the flowers of the *Pyrethrum cinerariæfolium*, a plant growing wild in Dalmatia, but whose cultivation is rapidly spreading. This is thought to be decidedly more powerful and more persistent in its action than the other kind, and justifies the higher commercial value. The discoid flowers of the plant are more powerful generally than the radiate; and as the former are larger, the greater activity of the Dalmatian flowers is due to the larger extent of the discoid portion in the Dalmatian plants. It is only after the flowers of the *Pyrethrum* are dried that their insecticide virtues are well developed. When fresh they exercise a slight action, but far inferior to that of the powder. It is said that in Vienna the druggists have on sale the dried flowers entire, as they are considered more effective and less liable to adulteration.—14 *A*, *March* 5, 1875, 503.

REMOVAL OF ACID FROM THE SOIL BY OIL-PRODUCING PLANTS.

It is said that land in the neighborhood of Torgau has been rendered fit for the production of wheat by planting it with rape-seed every two years; the oil-producing plants, like the *cruciferæ* in general, acting upon the soil like lime in the removal of acid.—9 *C*, *July*, 1874, 106.

AUSTRIAN PLAN FOR SUPPLYING AGRICULTURAL TEXT-BOOKS.

The need of appropriate text-books for instruction in various branches in agricultural science is every where very keenly felt. The Austrian Agricultural Ministry has attempted a very practical plan for supplying this want; namely, by offering rewards for authorship. Some ten different text-books for schools of various grades are desired, and sums varying from 900 to 2500 florins are offered for satisfactory manuscripts, the authors being allowed, in addition, whatever may be received therefor from the publishers.

CONTINUED SUPPLY OF GUANO.

More detailed accounts of a report which has been previously referred to, made by the embassador from Peru at

London, on the supply of guano in that country, have come to hand, and are calculated to relieve the fears so widely entertained of an early failure of the guano supply. On some forty-five different localities on the mainland and islands of the Peruvian dominions guano deposits are found, some of them amounting to millions of tons.

ARTIFICIAL GUANO.

The so-called Stummer's guano, prepared from human excrements by chemical treatment, by means of peculiar apparatus, has been in the market since 1869, in four different grades, adapted to different crops. The consumption of it has increased from 3000 hundred-weight, in the first year, to 10,000 in the past year. That exhibited at the Vienna Exhibition was in the form of a loose, dry powder, and was found, according to analyses by Moser and Siersch, to contain nitrogen, 1 per cent., 1 per cent., 1.13 per cent., 3.52 per cent.; phosphoric acid, 6.30 per cent., 10.69 per cent., 7.26 per cent., 15.06 per cent., in the four grades, respectively.—6 *C*, *July* 30, 1874, 308.

FIRST ANNUAL REPORT OF THE MASSACHUSETTS INSPECTOR OF FERTILIZERS.

The first annual report of the State Inspector of Fertilizers in Massachusetts, Professor Goessmann, of Amherst Agricultural College, contains considerable information about the more important of our fertilizing materials, their sources of supply, prices, and value.

From 30,000 to 35,000 tons of Peruvian guano are annually consumed in this country. This comes mostly from the Guanape Islands, and is somewhat inferior in quality to that formerly obtained from the Chincha Islands, the supply of which is nearly exhausted. Considering its composition, Peruvian guano is, when unadulterated, one of the best and cheapest fertilizers in the market. Of fish-scrap and fish-guano, large quantities are made on the coast of New England and Long Island. In 1872 some forty-two fish-rendering establishments were reported as in operation, producing 32,570 tons of scrap. Animal dust made of blood, meat-scraps, and bones from slaughter-houses; ground bones and bone-black waste, are also very valuable and of increasing importance,

It appears that superphosphates and ammoniated superphosphates constitute by far the larger part of our home-made fertilizers. Four fifths of the phosphoric acid in the superphosphates comes from South Carolina and Navassa Island phosphates. In the majority of cases the nitrogen is added in the form of some nitrogenous animal matter. Ammonia salts are very seldom, and soda or potash saltpetre more often used for this purpose. Crude sulphate of ammonia, Chili saltpetre (nitrate of soda), and German potash salts are also coming rapidly into favor. The higher grades of the German potash salts are much to be preferred to the lower, which contain large quantities of material of little fertilizing value; while the cost of freight in importation is as great as for the purer potash salts.

NEW GUANO DEPOSITS IN PERU.

Of all the states of South America, Peru appears to be most favored in regard to her financial condition, possessing as she does immense beds of guano, wholly controlled by the government, which furnish an ample revenue for all purposes. We chronicled not long since the discovery of new beds of this important manure, and we now learn that still later discoveries have been made of guano a few miles south of Iquique, which contain at least 20,000,000 tons of the fertilizer. Still other beds have also been found in the Bay of Independence, a few miles south of Pisco, the two together probably adding 25,000,000 tons of this substance to the treasury of Peru.

The quality of the new guano is said by Professor Raimoni to be excellent, although not containing quite as much ammonia as that formerly obtained from the Chincha Islands.—*Panama Star and Herald, March* 24, 1815.

CHEMICAL ANALYSES OF FERTILIZERS.

In the chemical examination of commercial fertilizers variations have often been found between the analyses of different samples of the same article. These differences may be due either to differences in the analytical methods employed or in the actual composition of the substances analyzed. To obviate the former source of error, the German experiment stations have given considerable attention to devising and

adopting uniform methods of analysis. At a meeting, at Magdeburg, of the chemists of the stations, in 1873, a definite plan for the determination of phosphoric acid was agreed upon, to be used by all. But differences have been found in different analyses of the same fertilizer, even when the same method has been followed. Dr. Märcker, director of the experiment station at Halle, has lately sought to discover the cause of these variations. Superphosphates, as commonly manufactured, are by no means powder of uniform fineness, but often contain large particles that have clumped together in the treatment with acid. It would be natural to presume that these lumps would have the same composition as the fine powder. Such Dr. Märcker finds is not the case. A number of superphosphates, made from guanos, bone-black, and bone-dust, were sifted through a sieve whose meshes (including wire) were one millimeter wide, and the coarser and finer portions were analyzed separately.

The finer portions contained from 2.8 per cent. more to 4.3 per cent. less phosphoric acid than the coarser. If, therefore, in the analysis even of a superphosphate made from as finely pulverized material as bone-dust or bone-black, the clumpy portions are omitted and the finer portions analyzed, it is easy to see how incorrect results may be obtained.

From these observations Dr. Märcker concludes that "in the selection of samples of fertilizers for analysis the greatest caution should be observed on account of the difference in composition of the coarser and finer particles. It is necessary that the samples be so prepared and pulverized as to afford a safe guarantee for the uniform mixture of larger and smaller particles." "It would be just to expect manufacturers to see to it that fertilizers be well mixed and finely pulverized. Doubtless the best way to secure this would be found in the refusal on the part of consumers to buy imperfectly prepared articles."—*Zeitschrift des Landwirthschaftlichen Vereins der Provinz Sachsen*, 1874, No. 1, 12.

ABSORPTION OF AMMONIA, ETC., FROM SOLUTIONS BY THE SOIL.

Among the conclusions reached by Eichhorn, from a series of experiments in regard to absorption by the soil, it is stated that hydrous double silicates of alumina and lime, as chabazite and stilbite, absorb the ammonia from solutions of

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free hydrochloric acid. Phosphoric acid is largely absorbed from a solution of phosphate of ammonia by chabazite and stilbite, and also to a great extent by chalk, but the addition of the latter to the chabazite does not increase its absorptive power for phosphoric acid or ammonia. From a solution of a superphosphate the phosphoric acid is taken up very rapidly by humate of lime, and less rapidly, but completely, by acid carbonate of lime and chalk. Other bodies, as stilbite, brown hematite, kaolin, and humic acid, appear to absorb but little or no phosphoric acid from solutions of superphosphates.—14 *C*, CCXVI., 1875, 92.

FISH-GUANO, PARTICULARLY THE FATLESS, DRIED, SO-CALLED POLAR FISH-GUANO.

According to Dr. Vohl, large quantities of a small species of herring, so-called sprats (*Clupea sprattus*), collected upon the coast of England, and crushed, have been employed as manure for wheat and hops with good results. A process was also patented in England in 1854, by Pettitt, for the preparation of an artificial guano from herring by means of sulphuric acid. Analyses of three samples of this guano gave 4.1 per cent., 23.2 per cent., and 3.5 per cent. of phosphates of the alkaline earths; and 13.8 per cent., 10.6 per cent., and 11.2 per cent. of nitrogen, respectively. This in-

verse variation of nitrogen, compared with that of the phosphates, indicates that the sample in one case was made almost exclusively of the flesh, while in the other case it included also a large amount of bones. Analyses of the so-called Norway fish-guano, which first appeared in the German market in 1862, also show great variations in the percentage of phosphoric acid, doubtless due to the same causes. Although fish are very prone to putrefaction, still many of the fish-guanos decompose with difficulty in contact with water. The remarkable resistance to putrefaction of some samples was doubtless due to the presence of a large amount of fat, which caused them to be moistened with difficulty, and consequently to absorb water very slowly. The presence of such an amount of fat may have been the cause, in many cases, of the unsatisfactory results of experiments with fish-guano as a fertilizer, and may explain why its action was not as rapid and evident as that of bird-guano. Recently, however, this obstacle to the rapid and certain effect of fish-guano has been removed by Radde, of Hamburg, by the manufacture of so-called fatless, evaporated, polar fish-guano, in which a minimum of 8 per cent. of non-volatile nitrogen, and of 12 per cent. of phosphoric acid is guaranteed, and actual analysis of a sample gave a considerable excess above this minimum. This article is in the form of a fine, dry powder, of yellowish color, with a comparatively feeble odor. It absorbs water rapidly, and when moist putrefies readily at 52°, with copious formation of ammonia. It yields on ignition 37 to 38 per cent. of ash. The phosphoric acid is present as a tribasic phosphate, and the nitrogen in non-volatile combinations, from which ammonia is only liberated, as they decompose in the soil, thus affording a rich continuous source of nitrogen to the plants, in which particular it surpasses bird-guano. As a solid manure it can replace any artificial manure; in some cases, however, potash should be applied with it in the form of wood-ashes. As a liquid manure its value is indicated by the fact that 33 to 34 per cent. of it passes into a solution in cold water, which, on evaporation, affords a residue, which contains, when dried at 212°, in addition to the soluble phosphates, 15 per cent. of nitrogen. In the liquid form it has been found excellent for vegetables, fruit, and pot-plants. Ex-

chloride of ammonium and phosphate of ammonia to a considerable extent, while the anhydrous double silicates, which are not decomposed by hydrochloric acid, do not absorb the ammonia, but those that are so decomposed do to some extent. By treatment with hydrate of lime these silicates take up water, and are rendered absorbent of ammonia, or, if so before, their absorbing power is increased. Carbonate of lime absorbs but little ammonia from a solution of chloride of ammonium, but somewhat more from a solution of the phosphate. Humate of lime and peat take out a considerable amount of ammonia and potash from solutions of their chlorides, with the passage of an equivalent amount of lime into the solution. Pure humic acid and peat, treated with hydrochloric acid, take up less ammonia and potash, under similar conditions. The chlorine in the preceding cases is not absorbed, but remains in the solution, in some cases combined with calcium in part, and in other cases in part as free hydrochloric acid. Phosphoric acid is largely absorbed from a solution of phosphate of ammonia by chabazite and stilbite, and also to a great extent by chalk, but the addition of the latter to the chabazite does not increase its absorptive power for phosphoric acid or ammonia. From a solution of a superphosphate the phosphoric acid is taken up very rapidly by humate of lime, and less rapidly, but completely, by acid carbonate of lime and chalk. Other bodies, as stilbite, brown hematite, kaolin, and humic acid, appear to absorb but little or no phosphoric acid from solutions of superphosphates.—14 *C*, CCXVI., 1875, 92.

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chloride of ammonium and phosphate of ammonia to a considerable extent, while the anhydrous double silicates, which are not decomposed by hydrochloric acid, do not absorb the ammonia, but those that are so decomposed do to some extent. By treatment with hydrate of lime these silicates take up water, and are rendered absorbent of ammonia, or, if so before, their absorbing power is increased. Carbonate of lime absorbs but little ammonia from a solution of chloride of ammonium, but somewhat more from a solution of the phosphate. Humate of lime and peat take out a considerable amount of ammonia and potash from solutions of their chlorides, with the passage of an equivalent amount of lime into the solution. Pure humic acid and peat, treated with hydrochloric acid, take up less ammonia and potash, under similar conditions. The chlorine in the preceding cases is not absorbed, but remains in the solution, in some cases combined with calcium in part, and in other cases in part as free hydrochloric acid. Phosphoric acid is largely absorbed from a solution of phosphate of ammonia by chabazite and stilbite, and also to a great extent by chalk, but the addition of the latter to the chabazite does not increase its absorptive power for phosphoric acid or ammonia. From a solution of a superphosphate the phosphoric acid is taken up very rapidly by humate of lime, and less rapidly, but completely, by acid carbonate of lime and chalk. Other bodies, as stilbite, brown hematite, kaolin, and humic acid, appear to absorb but little or no phosphoric acid from solutions of superphosphates.—14 *C*, CCXVI., 1875, 92.

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in general, finer. It is best prepared by throwing the leaves into boiling water, and, after pouring this off, cooking it as usual. Its cultivation is simple. The seed may be sown in a hot-bed in March, for subsequent transplanting, or in the open ground in April or May.—9 *C*, *December*, 1874, 183.

BEST SHAPE FOR FRUIT-TREES.

The majority of a convention of German pomologists expressed a decided preference for the pyramidal form for fruit-trees. The advantages claimed for it are the minimum of shade, greatest strength, avoidance of severe wounding of the tree, production of better fruit, and at the same time fewer disadvantages from storms, weight of snow, excess of fruit, theft, etc.—5 *C*, *July*, 1874, 105.

NEW FACTS IN THE HISTORY OF THE POTATO BLIGHT.

An important step has been gained in the natural history of the potato blight. It is stated that Professor De Bary, of Strasburg, has detected the existence of "heteræcism," or an "alternation of generations," in the life history of the *Peronospora infestans*, the parasitic fungus which causes the disease. It is conjectured that the second form may possibly be found on clover.

INVESTIGATION OF THE POTATO DISEASE.

Announcement has already been made of the selection of Professor De Bary, of Strasburg, by the Royal Agricultural Society of England to make a series of investigations into the life history of the potato fungus, for the purpose of filling up a certain blank in our knowledge of the development of this destructive object. This gentleman, in carrying out his investigations, has lately discovered that the disease is not propagated by defective tubers, and that although the mycelium was distinctly apparent in the stalks of plants raised directly from diseased tubers, yet that neither gonidia nor germs were evolved. He also expresses the hope that he has at last discovered the resting-places of the oöspores, or the active primary germs of the fungus. This is the special point upon which further information is needed, and may suggest the proper means of preventing the continuance of the disease in any given locality by warning agriculturists

against planting their potatoes in a spot where they must, at some time, inevitably be destroyed.—18 *A*, *Nov.* 20, 1874, 239.

FARLOW ON THE POTATO ROT.

A few years ago Dr. W. G. Farlow, of Cambridge, Massachusetts, visited Europe for the purpose of making a special study of the cryptogamic plants, and in this connection spent considerable time in the study of the subject, under the eminent Professor De Bary, of Strasburg. A recent number of the Bulletin of the Bussey Institution contains some of the results of this move on Dr. Farlow's part in an elaborate paper upon the potato rot. This is an important contribution to the natural history of the subject, embodying as it does the latest knowledge of this most destructive pest.

It should be remembered that Professor De Bary was commissioned by the Royal Agricultural Society of Great Britain to carry on investigations in this department, and the labors of Dr. Farlow give the results hitherto ascertained.

There are still some points in the natural history of the potato rot which are unknown, and which must be determined before any very positive preventive measures can be entered upon. Dr. Farlow sums up the whole matter by stating that there is no such thing as a specific against it; that is to say, there is nothing that will effectually protect the tubers and also prevent the further development of the fungus, as whatever completely destroys the fungus will be equally fatal to the potato itself; so that the only thing that can be done is to prevent as much as possible any harm to the plants in which the mycelium already exists, and the spread of the disease to healthy plants.

If the moisture in the air, about the time when the disease is likely to appear, say from the first of July to the middle of September, can be controlled, the mycelium would not increase to any extent so as to produce practically any harm. Unfortunately this can not be done; but the land can be thoroughly drained, or dry soil used for planting. The wetter the soil the more liable is the potato to rot. As the disease does not appear until about the first of August, early potatoes should be less likely to rot than late ones. But exactly what variety farmers should plant is not a question for the botanist. Although certain potatoes seem to resist the

disease better than others, yet none are free from liability to decay. Dr. Farlow remarks that the precautions which should be taken to prevent the extension of the disease will be more definitely known when the plant in which oöspores are produced has been discovered. At present we can not say with certainty that these are found either in clover, wheat, oat, or rye straw, and therefore the prohibition to plant after any of the above-mentioned crops is without foundation. It is thought probable, however, that the oöspores of *Peronospora infestans* will be found concealed in some common plant eaten by cattle; and as these oöspores are so tough as not to be affected by passing through the alimentary canals of animals, the chances of avoiding the rot are greater when mineral manures are made use of than animal. Dr. Farlow also puts in a word of caution in reference to the fungus of the lettuce, which he states is increasing very rapidly in New England, and is a subject worthy of serious consideration.

CULTIVATION OF THE ASPARAGUS IN FRANCE.

There are few vegetables in which the result of special care in cultivation has been more marked than in the case of asparagus, which, from the old-fashioned stringy, slender, and tough spike, has been converted into a tender, succulent mass of agreeable food. This result is due particularly to the labors of the French, asparagus having been cultivated in France for a long time, especially in the vicinity of Argenteuil, near Paris.

In former times the beds in which this plant was cultivated were managed without reference to other crops; but more recently the plant has been reared in the vineyards, the grape and the asparagus agreeing very well together. At present the vineyards of Argenteuil furnish from eight to twelve hundred dollars' worth of asparagus annually per hectare (2½ acres), or from three to five hundred dollars' worth per acre.

The asparagus bed is started in March or April, with shoots obtained by sowing under glass in open, light, well-worked soil, isolated as much as possible from surrounding vegetation, the earth being dug out to the depth of about eighteen inches. Trenches of these dimensions are first prepared, being separated from each other about four inches, in

the centre of which the shoot is placed, upon a little hillock of earth, with its roots carefully spread out. The whole is then carefully covered with earth and with a small quantity of manure. The air must be allowed to penetrate the bed, this being secured by stirring up the soil from time to time.

Care must be taken to destroy or remove snails, insects, and other things injurious to the plant. In October, during dry weather, the stems of the asparagus are to be cut at a height of about six inches above the surface of the ground. A small quantity of manure is then to be placed around the plant and covered with a thin layer of light earth, so as to form a little hillock around the shoot some inches in height. The same precautions are to be taken each year; but it is not until the fifth year that the asparagus can be collected to advantage.

The shoots should be gathered once or twice a day, preferably in the morning, and should never be cut, but should be bent a little downward and then slightly twisted, thus detaching the top readily from the stump. By taking all the necessary precautions, especially in preventing too great action of light upon the asparagus, plants of extraordinary dimensions and excellence can be obtained, varying in price in Paris from one fourth of a franc to five francs each. A single plant has been known to furnish five dollars' worth of asparagus in a single year. When it attains, as it sometimes does, an excessive growth, the plant loses its original form and becomes very much flattened, the edges curling round in the form of a half-closed tube. This is technically termed fasciation, and frequently occurs in other plants.—13 *B, July* 10, 81.

NEW DISCOVERY IN CONNECTION WITH THE POTATO DISEASE.

There has been hitherto one "missing link" in our knowledge of the life-history of the potato-blight—*Peronospora infestans.* The non-sexual mode of reproduction by gonidia, or zoospores, has long been known; but the sexual mode of reproduction has eluded observation. This link has now been supplied through the researches of Mr. Worthington Smith, who described his discovery in a paper read at the last meeting of the Scientific Committee of the Royal Horticultural Society, and published at length in the *Gardener's*

Chronicle for July 10, 1875. He finds the female organs, the "resting-spores," or unfertilized "oospores," and the male organs, or "antheridia," in the interior of the tissue of the tuber, stem, and leaf when in a very advanced stage of decay; and he has actually observed the contact between the two organs in which the process of fecundation exists. In some remarks made at the meeting of the British Association last year, by one of our high authorities, it was suggested that we have in the *Peronospora* an instance of the phenomenon not infrequent among fungi, known as "alternation of generations;" and that the germination of the true spores of the potato-blight must be looked for on some other plant than the potato. Mr. Worthington Smith has, however, looked nearer home, and has proved at all events that the suggestion is not verified in every case.

CONTINUOUS CORN-GROWING.

Some agricultural authors insist that corn-growing can not pay in England, and that the increasing expense of cultivation must shortly consign large tracts of arable land to grass. Two spirited agriculturists, Messrs. Prout and Middleditch, of England, have helped materially to solve some of the difficulties of clay farming. They have demonstrated the agricultural capabilities of stubborn clays, for their practice shows how successfully they may be cultivated; have profitably grown cereals on the same heavy land for several consecutive years, and continue annually to dispose of the whole of the increased products. Mr. Prout's farm comprises 450 acres, and was in such poor condition that it was with difficulty rented at twenty shillings per acre. The land was wet, and was overrun with weeds and overshadowed with crooked fences. The best portions of it produced twelve bushels of wheat and twenty bushels of oats per acre per year. Since 1861 Mr. Prout has built commodious dwellings for his laborers, dug new wells, ditched and drained the whole farm, altered the fences and hedge-rows, and reclaimed the waste land to such an extent that eighteen acres have been added to the productive area of the farm. From the beginning Mr. Prout has employed steam-power, and at every practical step the steam-plow so effectually disintegrated the formerly sour, stiff clay, admitting frost, air, and sun, that

after the first few years full crops grew with a little extra manuring; and even cereals were grown consecutively with the employment of about twenty shillings per acre of artificial manures. Experience, however, has shown that to prosecute his system successfully, fifty or sixty shillings per acre of manure must be applied annually.

But Mr. Prout has done more than to bring into superior and profitable cultivation 450 acres of heavy clay land, worth thirteen years ago not more than twenty shillings per acre. He has inaugurated an almost original system of husbandry. All ordinary rotations are ignored; corn crops follow each other on the same field for several consecutive years. Wheat has been grown for five successive years, and the cereals have been repeated for eight years. Mr. Prout is no mere theorist. He brought to his labors the experience acquired from many years in Cornwall and in Canada. He determined to sell, year by year, the whole of his growing crops, and to restore an equivalent in the form of portable fertilizers. For his consecutive corn crops Mr. Prout only desires deep, thorough cultivation, extirpation of weeds, and a regular supply of manure. His crops are sold a week or ten days before they are ready for the harvest, the neighboring farmers being his principal buyers, and superintending their own harvesting and threshing. The labor question troubles Mr. Prout less than many of his neighbors. His steam-tackle economizes both horse and hand labor, and keeps his labor account under thirty shillings per acre. He expends upward of £1200 annually on portable manures. Bones, mineral superphosphate, guano, and nitrate of soda are generally preferred. The average annual receipts of his farm are £4800, out of which it is estimated that he has an annual profit of £825. That the consecutive grain crops taken off have not exhausted nor deteriorated the land is evident from the improved quantity and quality of the growing crops, and the increased value of the farm, which would now bring double the price paid for it by Mr. Prout. Very few land investments, or any description of investments, pay, like Mr. Prout's, a fair interest on the outlay, and double their value in thirteen years.

The farm of Mr. Middleditch, before referred to, has been treated in a very similar manner, and with the same encouraging results.

FIELD EXPERIMENTS WITH VARIOUS FERTILIZERS AT THE BUSSEY INSTITUTION.

The "Trials of Various Fertilizers upon the Plain Field of the Bussey Institution" of Harvard University, by Professor F. H. Storer, are much more elaborate, accurate, and useful than any other field experiments ever attempted in this country, and will, if continued, excel in these respects all European ones except those of Lawes and Gilbert at Rothamstead, in England.

The motive of these experiments has been "to determine, if possible, what kinds of fertilizers, among those ordinarily obtainable in Boston, are best fitted to increase the yield of crops grown upon a field that had been chosen as the typical representative of the thin, light, 'leachy' soils which so frequently overlie the gravelly drift in New England." The plan has been to divide the field into plots, and to raise upon them different crops with different kinds of manure, repeating the same crop on the same plot, with the same manure, year after year. Three kinds of crops—barley, beans, and ruta-baga—were grown. Yard and stable manure, muck, fish-scraps, lime, bone-meal, superphosphates, salts of ammonia, potash and soda, and other fertilizers were used, either singly or in combination with each other. The experiments were commenced in 1871, and reports for four years (1871–4) are now issued.

An idea of the magnitude of the work may be obtained from the fact that some 285 experimental plots, each five meters (= about one rod) square, have been cultivated, some during the whole, and others for part of this time. The experimental crops suffered somewhat from the casualties to which crops in general are exposed, such as heavy rainstorms, depredations of animals, failure from bad seed, and particularly from drought. The repetition of the experiments through a series of years, however, served to make up for the disturbances from these causes, so that the general results are, on the whole, quite conclusive and reliable. The conclusions apply, of course, to such soils as that of the experimental field, and only in a more limited degree to others.

In one respect, however, these experiments have a very

great value. Most of the investigations upon which the accepted theories of agricultural science are founded have been made in Europe, where circumstances obtain, in many respects, different from our own. And so long as we depend entirely upon results of European experience to guide our practice, we shall run the risk of falling into error. A number of illustrations of this truth are brought out by these experiments of Storer.

In the experiments described above it was found that potassic manures yielded the best crops, while phosphates and nitrogenous manures did but little good, and in some cases positive harm. The largest crops were obtained with farm and city stable-manure, and with wood-ashes. Nitrate, sulphate, and carbonate of potash (pearlash) likewise brought large returns. In a summary of comparative results, wood-ashes proved more efficacious than any other single fertilizer, the yield being larger than with either yard or stable manure.

Professor Storer concludes that the soil needed potash rather than phosphoric acid or nitrogen. "The addition of potassic manures to the soil manifestly enables the crops to make use of a certain store of phosphoric acid and nitrogen that the land contains. It is clearly shown, moreover, that the amount of available potash in the soil must be very small, since neither the phosphatic nor the nitrogenous manures by themselves, nor mixtures of the two, such as several of the so-called superphosphates are known to be, could enable the crops to get enough potash from the soil to keep them from starving after the first year." And further, "It is plain that the soil of this field, like those of thousands in New England, needs fertilizers that are rich in potash, and that, under the existing condition of things, no advantage can be gained by applying mere phosphatic and nitrogenous fertilizers to the land. . . . If only potash enough be given to this soil, the latter can of itself supply all the other ingredients that compose the food of plants, at least for the term of years during which the experiments lasted, and for as many more, of course, as the store of phosphates and nitrogen may hold out. . . . The crying want of the land is for potash, and potassic manures should be applied to it to the well-nigh complete exclusion of all other fertilizers until an equilibrium can be reached."

Besides the results of his own experiments, Professor Storer finds proof of the lack of potash in New England soils in the common impressions and practice of farmers. Good farmers about Boston maintain that wood-ashes and the so-called "long" horse-manure from city stables, which contains a good deal of straw, are worth more than night-soil and Peruvian guano. These all, except the ashes, are rich in nitrogen, and all contain phosphoric acid. The night-soil, and particularly the guano, a good deal. But the night-soil and guano are poor, and the ashes and strawy horse-manure rich in potash. The fact, then, that on soils in the district near that of the experiments ordinary practice shows the long horse-manure and ashes to be more useful than guano and night-soil is an additional proof of the lack of potash in these soils. The guano and night-soil, with their large supplies of available nitrogen, would temporarily stimulate the growth of plants, but the result would be a speedy exhaustion. That is to say, these fertilizers would enable the plants to make speedy use of the small amount of available potash in the soil; but thereafter, until the potash was re-supplied, a large yield would be impossible.

The widely prevalent opinion that, in nearly all cases, nitrogen and phosphoric acid are the only important ingredients of commercial manures is of essentially transatlantic origin. In European practice, the lack of phosphoric acid and nitrogen has been felt more than that of potash. Mr. Lawes, who, with Dr. Gilbert, has conducted the famous experiments at Rothamstead, England, states that "the only two substances really required in artificial manures are, first, nitrogen; second, phosphoric acid;" and that "potash is generally found in sufficient quantities in soils, and the artificial supply is not required." This opinion is evidently based upon his own experience and observations on the other side of the Atlantic. In England and on the continent of Europe the great bulk of commercial fertilizers are bought for the phosphoric acid and nitrogen they contain, though in Germany, especially, potash salts are coming into very general use.

As Professor Storer points out, the circumstances affecting the amounts of plant-food in the soil in New England have been different from those in Europe. Here grass and forage

crops, with very little grain, make up the chief produce of the soil. But little dung has been applied, nor has the custom of returning straw to the soil ever prevailed as in Europe. Clearing land by burning wood has probably aided the exhaustion. "No doubt other matters besides potash have been removed from the land by these practices, nor that, in many instances, phosphates are needed also; but the evidence would seem to show that, in the present case, the supply of potash originally contained in the land has given out first. It is no great matter of surprise that this thing should have occurred in a country mainly devoted to grazing and the growth of forage. If New England had been a grain-growing country, phosphoric acid might perhaps have been its weakest point.

In the field experiments of Messrs. Lawes and Gilbert, in England, alongside of heavy crops that have been raised, year after year, on manured plots of land, smaller yet not inconsiderable yields had been obtained in successive croppings, on similar plots, without manure. This has served to bring out very forcibly the fact that soils have a certain capability of re-supplying the plant-food removed in cropping by the working over of materials present in greater or less quantity in every soil, into forms fit for the nourishment of the plant. To this restoring power the term "natural strength" has been applied.

In Storer's experiments, crops of some, though limited, size were obtained without manure. By adding moderate quantities of appropriate manure a much greater yield was obtained. But an increase in the manure above this amount was not followed by a corresponding increase of crop. Very heavy manuring was not economical.

In the causes of this are to be found some principles of great practical importance.

From the fact that only very small crops were obtained without manure, Storer concluded that the natural strength of his soil, in the sense above referred to, is not great.

But there is another sense in which this term may be used, and another condition of the capability of a soil for producing crops, besides its capacity for working over into available forms the stores of plant-food it may contain. It is important that it should be able to utilize, economically,

the manure it receives. And this latter is an important factor of the natural capability of a soil.

The soil experimented on by Storer was deficient in both these respects: in capacity for yielding good crops from its own stores, and in power to make large returns for large supplies of manure given to it. The reasons are very clearly set forth in Storer's report. In order that plants may grow well, each one of a number of conditions must be fulfilled. Not only must all the essential ingredients of plant-food be present in abundance, but there must be proper supplies of light, heat, air, and moisture.

"The experiments of the German chemist, Hellriegel, show most clearly the enormous influence that is exerted upon the quantity of a crop whenever one of these conditions is unfulfilled, or only partially fulfilled. By attending to all these particulars, Hellriegel has succeeded in growing, year after year, several grain crops, much larger, healthier, and more perfect in every respect than have ever been met with in field practice. He has been able, moreover, to produce at will plants of determinate size and weight by varying the conditions aforesaid, though the supply of food was unchanged." In fact, within certain limits he was able to make the size of his crops very nearly and regularly proportional to the amount of water they received.

Now the application of these principles to Storer's experiments is plain. The soil is peculiarly subject to drought. Without an adequate supply of moisture, crops grown upon it are unable to make full use of the plant-food contained therein. Hence heavy manuring of such soils is not economical.

There are many practical and theoretical farmers who advocate with little discrimination the doctrine of "high-farming," and point to European practice in support of their view. One limitation to this doctrine is forcibly illustrated in Storer's experiments. As was said above, the soil on which these experiments were made was not "strong" enough to give manure the support it needs in order that its fertilizing constituents may be used with advantage. This was due to its lack of depth, and above all to its lack of water. "Like thousands of others in New England, their field has a *certain natural but limited capacity to profit by the application of*

manure. . . . The results of three years' experiments show conclusively that under the conditions which now obtain the land is unfit for any system of 'high-farming.' On the contrary, to be farmed with profit, it must be given over to some system of low-farming, where expenditures for labor, tillage, and fertilizers shall be small and the crops proportionally light." True economy would consist in learning how much production can be profitably obtained, to depend upon the natural strength of the soil so far as it will avail, and only supply manure for the rest.

And the same principle applies to more than the light, dry soils of this country. In the best farming countries of Europe, from which most of our agricultural science hitherto has come, land is very dear, capital is comparatively cheap, and there is a market near every farm. There, as Professor Storer says, "the problem may be almost said to be: Given standing-room, how to get the largest possible yield from the land; and that is profitably done by 'high-farming,' even though some materials are thus stored up in large excess in the soil." With us land is cheap, and capital needed for manure and labor dear, and the market often distant; and the aim of the farmer ought generally to be "to use up the natural force of his land most fully, without injuring or in any way weakening it, and, slowly if need be, but with constant profit to himself, to increase the original fertility until it is completely in accord with the other circumstances by which the profits of his farm are limited and controlled."

A great many attempts to renovate worn-out lands by the use of commercial manures prove unsuccessful. In such cases failure is apt to be ascribed to the poor quality of the fertilizers used, and the manufacturer or seller is accused of dealing in spurious wares. That such accusations are sometimes well-founded is only too true. But articles of fair or even the highest quality are often misapplied, or the conditions of growth dependent upon moisture or other agencies are unfavorable. The ill results are oftener due to these causes than to frauds in fertilizers. In some of his field experiments Professor Storer obtained smaller crops of beans and barley on plots treated with bone and other phosphates than on contiguous plots which received no manure at all. The phosphates then, instead of increasing the crops, actually

reduced them. This injurious action of phosphates Storer has known only on poor soils. To investigate the cause, he "tried a number of experiments in pots with the view of determining how large an amount of phosphatic manure may be safely applied to sterile land. From the results obtained it would seem that bone-dust and other phosphates, when present in too large a quantity, may exert an exceedingly hurtful influence upon the development of the plumule, or first sprout that springs from the seed, especially at the time when the young shoot is ceasing to draw nourishment from the seed, and is beginning to live upon matters derived from the soil and air. It appears that the young seedling can not endure the presence of a certain excess of phosphate of lime; at least when the soil in which it stands is too poor to supply at once all the food the plant may need.

The superior value of superphosphates is, in general, ascribed solely to the fact that, being in the soluble form, their phosphoric acid is more readily imbibed by the roots of the plant, and they thus become immediately available as plant-food. In view of the fact that contact of too much phosphate with the seed may cause the young plant to perish almost at its birth, Professor Storer suggests that the superphosphate may be better, because safer. The soluble phosphate will be more uniformly diffused through the soil, so that no hurtful excess may in any place come in contact with the roots.

J. PISCICULTURE AND THE FISHERIES.

REPORT OF THE FISH COMMISSIONER OF CANADA.

The report of Mr. William F. Whitcher, Commissioner of Fisheries of Canada, made to the Minister of Marine and Fisheries, on the operations of his department for 1874, is, like its predecessors, a document of very great value, and especially so on account of the very full and accurate statistics of the yields of the products of the sea and the rivers of the various parts of the Dominion.

According to this report, the condition of the fisheries generally is improving, their money value in 1874 amounting to $11,681,886, or an increase of nearly $1,000,000 over that of the preceding year. This, of course, embraces fish and fish products for exportation, while ten per cent., it is thought, should be added to represent the domestic consumption. The products of British Columbia, Manitoba, and the northwestern territories are not communicated.

Of the sum mentioned, Nova Scotia is credited with $6,652,000, New Brunswick $2,685,000, and Quebec $1,608,000, with smaller quantities for Ontario and Prince Edward's Island.

The report also includes an account of what has been done in the Dominion in the way of artificial propagation of the salmon; and we are informed that there are five fish-hatching establishments now in successful operation—namely, at New Castle (Ontario), Tadousac, Gaspé, Restigouche, and at Newcastle (New Brunswick). The quantity of eggs laid down in these five establishments exceeds four millions, of which about eighty-three per cent. will probably become young fish. Similar establishments are recommended for Nova Scotia, Prince Edward's Island, the Eastern townships, and on Detroit River, near Sandwich. A favorable place has been found near the Narrows, among the Thousand Islands, on the Canadian shore of the River St. Lawrence, for hatching and rearing such fish as bass, pickerel, and muskallonge.

Special attention is called by the Commissioner to the importance of the salmon of British Columbia and Frazer's

River. Acknowledgments are made to the United States Fish Commissioners for the donation of a number of eggs of the California salmon, which were hatched at the establishment at New Castle, Ontario.

Of interest to some American salmon fishermen, who resort in so great numbers to the rivers of the Dominion for the purpose of taking salmon with the rod, is a table, giving the number of captures in all the rivers in the provinces of Quebec and New Brunswick. The largest credits are 1311 to the Restigouche, and 654 to the Nepissiguit. Next to these the Great Cascapedia furnished 418 fish, of an average weight of twenty-three and a half pounds, the largest fish weighing forty-eight and a half pounds.

NINTH ANNUAL REPORT OF THE MASSACHUSETTS COMMISSIONERS OF FISHERIES.

The Massachusetts Commissioners of Fisheries have published their ninth annual report, for the year ending January 1, 1875, which, like its predecessors, occupies a prominent part in the histories of state and national measures taken for multiplying the food fishes. The principal work of the Commissioners consisted in hatching the eggs and planting the young of the California and Maine salmon, and the hatching of shad in the Merrimac River at North Andover. A few land-locked salmon were also obtained from Sebec, and distributed to different parts of the state. The number of shad caught at Andover, in 1874, was 1680, which furnished 6,249,000 spawn. Of these 3,500,060 were hatched and distributed in various waters of the state. The average of the yield of eggs was 10,278 to each female.

NINTH REPORT OF THE FISH COMMISSIONERS OF CONNECTICUT.

The ninth report of the Fish Commissioners of Connecticut, made to the General Assembly at the May session of 1875, has been published by these gentlemen, and contains the usual evidence of their activity and energy in prosecuting the labor intrusted to them. They report a good deal of work in stocking the ponds of the state with black bass, as also in the hatching of shad in the Connecticut River, and their distribution. They are quite satisfied that the measures taken by the state to multiply this last-mentioned fish

have been successful, the number caught during the past season having been unusually great, and the price being correspondingly cheap, while, in addition to all this, the average size of the fish has been increased.

They report considerable difficulty in carrying out the laws of the state in reference to the establishment of fish-pounds in Long Island Sound, having been enjoined from proceeding against certain delinquents by the societies sustaining such establishments.

They have much to say also of the prospect of success in regard to the introduction of the California salmon from the United States fishery on the M'Cloud River, thinking the fish to be eminently adapted to the waters of their state.

FIRST REPORT OF THE COMMISSIONERS OF FISHERIES OF MICHIGAN.

The first report of the State Commissioners and Superintendent of Fisheries of Michigan for the years 1873–74 has just been published, and exhibits the operations of a very energetic and active board for the period mentioned. A hatching-house has been established at Pohagan, near Niles, where large numbers of whitefish, salmon, and salmon-trout have been hatched out, and distributed throughout the state. A great deal has already been accomplished by means of the liberal appropriations on the part of the state toward restocking the waters with useful fishes; and should these labors be continued for a few years, Michigan will have but little to ask for in reference to the restoration of her former very extensive fishery privileges.

The Commissioners first appointed were Governor John J. Bagley, George Clarke, and George H. Jerome. Mr. Jerome has, however, been appointed Superintendent of the State Fishery Establishment, and his place on the Commission has been filled by the appointment of Mr. A. J. Kellogg.

The fish most important to Michigan at present is the whitefish, which occurs on every side of the state, and has heretofore constituted the basis of a very extensive business. The decrease, however, has been more and more marked year by year, and it is quite probable that but for the efforts which have been initiated, and are likely to be continued, on the part of the state, the economical value of these fish would

have been practically done away with. By restoring their original abundance, and even more, and adding the shad, the California salmon, and the Eastern salmon to the number of the inhabitants of the Great Lakes, and introducing the land-locked salmon into the lakes of the interior, the problem of cheap food for the people in Michigan will be measurably solved.

FIRST ANNUAL REPORT OF THE FISH COMMISSIONERS OF MINNESOTA.

The first annual report, for the year 1874, of the State Fish Commissioners of Minnesota has just been printed by order of the Legislature. In this the Commissioners, Messrs. Day, Austin, and Latham, call attention to the great proportion of water acreage in Minnesota, and the advantages of the state for fish-culture. According to their calculation, there are, exclusive of Lake Superior and Lake Pepin, and of rivers, no less than 1,601,848 acres of inland lakes alone, or about three and one third acres of water to every hundred acres of land. In addition, the Commissioners claim for the state the existence of some of the most important food fishes of the West, chief among which they consider the whitefish. This is of very great importance to the inhabitants of the state, and nearly 20,000 Indians in Northern Minnesota subsist almost exclusively upon it. An account of the measures taken for the disposition of the shad and salmon placed at their command by the United States Fish Commissioner is also presented by them.

FIFTH REPORT OF THE FISH COMMISSIONERS OF RHODE ISLAND.

The fifth annual report of the Commissioners of Inland Fisheries of Rhode Island, made to the General Assembly in January, 1875, has been published, and contains an account of what has been done by the Commissioners in pursuance of their trust. The efforts of the Commissioners have been largely directed toward restocking the rivers of the state with salmon, of which about 200,000 young were introduced into sundry rivers, particularly the Pawtuxet. Many young salmon were seen in the stream during 1874, and the prospect of success is very encouraging.

The Commissioners render their acknowledgments to the United States Fish Commission for a large supply of young shad placed in the Pawtuxet and other rivers.

An extended distribution of eggs and spawn of trout was also made. A good deal was also done with black bass; and it is probable that before long every considerable body of water in the state will be supplied with this fish.

In an appendix to the report is given a list of the various laws that have been passed for the regulation of the fisheries in Rhode Island.

REPORT OF THE FISH COMMISSIONERS OF PENNSYLVANIA FOR 1874.

The State Commissioners of Fisheries of Pennsylvania have published their report for the year 1874, and give a satisfactory exhibit of their activity during the year. They remark that, owing to some as yet unexplained fatality, the indications of the increase of black bass during the year are not so great as they had expected, and that the number of young fish caught in the streams is much less than that of the previous seasons. They suggest that this may be in part due to the covering up of the spawning-beds and the destruction of the spawn in consequence of heavy freshets during the critical season.

Attention is called to the destructive character of the pound nets and other fishing improprieties in Lake Erie, and the action of the Legislature is invoked for a remedy.

The fish-way, constructed at great expense, for the passage of shad at the Columbia Dam, the Commissioners believe, with the alterations recently made, will be adequate to its object. During 1874 the low stage of water and other circumstances combined to prevent the upward passage of the fish for a certain part of the season, although, when a sufficient flow passed through the chute, a considerable number are supposed to have ascended.

The shad-hatching operations of the past season were conducted on the Susquehanna River, just below the Columbia Dam, and from 174 spawning fish 3,205,000 eggs were obtained (an average of rather less than 18,500), and 3,065,000 young fish hatched out. The work extended from the 29th of May to the 24th of June: The highest temperature observed in

the river during the period was 82° (on the 9th of June), the water being only 75° on the 22d.

The report gives a table of the distribution of California salmon and the salmon of Maine from eggs received from the United States Fish Commission and hatched out at the state establishment at Marietta; as also of another supply hatched out at Dr. Slack's place at Troutdale, New Jersey. The localities where these were planted are also indicated in the report.

The Commissioners are satisfied that the efforts in regard to California salmon have proved a success, and that after a few years both the Delaware and the Susquehanna will abound in this important addition to the food resources of the country. They remark that they have seen the young California salmon, from four to eight inches in length, taken with the hook and line.

A good deal was done by the Commissioners in the distribution of salmon-trout in the rivers of Pennsylvania, 67,600 having been planted in different localities.

REPORT OF THE FISH COMMISSIONERS OF NEW HAMPSHIRE FOR 1874.

The report of the Commissioners of Fisheries of the State of New Hampshire, for 1874, has just been published, and gives an account of the labors of the new Commissioners, Messrs. Noyes, Wadleigh, and Fifield, who superseded the former officers about a year ago. Owing to the short period during which they have held office, they have not much to record, although they promise to carry on their work as vigorously as the means at their command will allow.

They propose a somewhat different method than that usually employed for stocking the waters, namely, the transfer of parent fish themselves, instead of depending upon the eggs or the young. They announce that they have made arrangements to put several thousand whitefish from Lake Champlain into waters of the state best suited to their propagation. They intend to introduce shad into some of the larger rivers as soon as they can obtain the mature fish, deeming it far preferable to the introduction of the eggs or young fry. If they can devise some method of keeping large shad for even a few hours in a confined body of water, and of transporting

them, they will accomplish an important feat in fish propagation, as, so far, the most careful manipulation has been unsuccessful. Even where the fish have been caught in large seines, and simply lifted by net or by hand into an adjacent inclosure for the purpose of keeping them until the eggs were entirely mature, they have always died in a very short time, possibly owing to the extent to which the scales become detached, and the consequent injury to the system.

SECOND REPORT OF THE FISH COMMISSIONERS OF VERMONT.

The report of the Fish Commissioners of the State of Vermont (Drs. Edmunds and Goldsmith) for 1874 (being their second) has been published by the Legislature, and contains an account of the measures adopted by the Commissioners for restocking the rivers of the state with useful food fishes. The importance of this interest to the state is shown, according to this report, by the large water area possessed by Vermont in proportion to its entire extent, there being scarcely a town without some natural body of water in it, susceptible of being made profitable to the people if suitably stocked with fish. According to their estimate there are 145 natural ponds in the state, having an area of 50 acres and upward, making an aggregate of over 77,000 acres now inhabited by worthless kinds of fish, of no economical importance. These can be filled, after a time, with suitable species, adding much to the resources of the state. The action of the Commissioners has related more particularly to the introduction of shad and salmon, which, with the assistance of the United States Commissioner of Fisheries, they have been enabled to effect on a large scale; the aggregate of 35,000 California salmon, 160,000 Maine salmon, and 775,000 shad having been safely planted in the waters of the state during the year.

FIRST REPORT OF THE FISH COMMISSIONERS OF WISCONSIN.

In the spring of 1874 Messrs. William Welch, A. Palmer, and R. R. Hoy were appointed by the Governor of Wisconsin Fish Commissioners of the state, in compliance with an act of the Legislature. Their first report has now been published, in which they give an account of their labor during the year. In consequence of the late period at which their appointment was made, and the limited amount of money at

their disposal, little was accomplished; but they express the hope that, with proper support from the Legislature, they will be able to do a great deal in increasing the supply of fish food. They also strongly urge the propriety of establishing a state hatching-house, in which eggs of the whitefish and the various species of salmon can be developed, and distributed to suitable waters throughout the state. They point to the great number of lakes in Wisconsin, there being no less than 225, covering 388 square miles, and occurring in sixteen counties alone. These are at present comparatively unproductive, but are capable of sustaining a very large number of fish.

THIRD ANNUAL REPORT OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The third annual report of the American Fish-culturists' Association, just published, contains the proceedings of the annual meeting held in New York on the 10th of February, 1874. On this occasion a large attendance was present, consisting of the most prominent fish-culturists of the country, together with the Fish Commissioners of the several states and of the United States. The most important communications made were as follows: On "The Introduction of Eastern Fish into the Waters of the Pacific Slope," by Livingston Stone; on "The Experiences of a Practical Fish-culturist," by Seth Green; "Salmon-breeding at Bucksport," by Charles G. Atkins; "Report on the Work of the United States Fish Commission," by S. F. Baird; on "The Fish-Ways of Pennsylvania," by James Worrall; and on "Laws for the Preservation of Fish," by Charles Halleck.

MEETING OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The usual annual meeting of the American Fish-culturists' Association was held in New York on the 9th and 10th of February, 1875, at the office of Mr. George Shepard Page, a leading member of the body in question. A large attendance was present from most parts of the country, embracing some of the most accomplished and successful fish-culturists of the United States and Canada. Among the more notable persons present were Hon. Robert B. Roosevelt, president of the association, Mr. A. S. Collins, Seth Green, Fred Mather, Dr. Hud-

son, and Mr. Pike, of Connecticut, E. A. Brackett, Dr. M. C. Edmunds, B. B. Porter, A. A. Anderson, H. J. Reeder, Rudolph Hessel, and others.

Various communications in reference to practical pisciculture were presented and discussed during the meeting.

On the 11th of February a meeting of the State Fish Commissioners was held at the Fifth Avenue Hotel, called by Professor Baird, the United States Fish Commissioner, the principal object being the consideration of the most important subjects connected with the labors of the State Commissioners. Mr. J. W. Milner, the Assistant Commissioner of Fisheries, read a paper, which was considered, and recommended by the meeting for publication.

OBJECTION TO THE USE OF SUBMERGED NET-WEIRS.

Special attention is called to the propriety of forbidding the use of submerged net-weirs in the waters of Lake Champlain for the capture of whitefish, a custom which, in the opinion of the Commissioners, will inevitably result, in a very few years, in causing the practical destruction of this valuable article of food.

FISHERIES AND SEAL-HUNTING IN THE WHITE SEA AND NORTHERN OCEAN.

Mr. Alexander Schulz, of Russia, has lately communicated to the Geographical Society of Dresden an important paper on the fisheries and seal-hunting in the White Sea and Northern Ocean, of somewhat the same character as his elaborate paper on the fisheries of the Caspian, published at Vienna, to illustrate a collection of specimens exhibited at the Exposition. In his last paper he remarks that most of the fishing villages are situated on the south and southwest shores of the White Sea, but that along the Murmanian coast, which stretches as far as Norway, there are no regular fishing settlements, and only huts and storehouses, unoccupied during the winter. From April to the middle of August, however, about 5000 fishermen repair thither from the shores of the White Sea to take part in the cod-fishery, the annual value of which amounts to about two millions of rubles. The most important fishes of the region are cod, salmon, and herring, which are prepared in various ways for the market. Between July

and September many vessels go from the coast villages to Nova Zembla in search of seals, walruses, bears, and a small species of salmon. Dolphins or porpoises are taken in abundance, and there are extensive hunting-grounds.—6 *A, October*, 1874, 311.

CLOSE TIME FOR THE CAPTURE OF SEALS.

An attempt has just been made by the governments of Great Britain and Norway to establish a close time for the capture of young and old seals. It has heretofore been the practice of those engaged in this trade to start out in March, and commence the capture immediately. The result is the destruction of large numbers of female seals while their young are still on the ice, and incapable of taking care of themselves; these young also perish, and, in consequence, the present method of capture threatens extermination to the seals, or at least their reduction to such limited numbers as to render them of comparatively little commercial importance. It was originally suggested that the 1st of April be fixed upon as the day for the commencement of the pursuit. It is now proposed, however, that it be the 5th or 6th instead. If the young are captured later than this they are not only of greater commercial value, but also, in the event of the loss of the mother, they are better able to take care of themselves. As to the time of closing the fisheries, it is suggested that this need not be fixed, as after the middle of May the old seals become very wild, and few can be captured, although the 30th of June might be indicated as satisfactory. The Norwegians do not seem inclined to accept the later date of April, and the 3d of April is suggested as a compromise.

BAD CONDITION OF THE HAIR-SEAL FISHERIES.

Frank Buckland gives a report, obtained from Captain Gray, of Peterhead, in regard to the hair-seal fisheries of the North Atlantic during the year 1874. In this he states that the yield has been less than at any previous period, and that unless prompt measures are taken for its restoration the business will become practically worthless. One of the most successful in a fleet of thirty-three steam-vessels obtained but 2600 seals. At a conference with sailing captains, called by the Board of Trade, the opinion was expressed that a close

time for seals is absolutely necessary, or they will become exterminated. The time allowed for the destruction of seals it was thought should be from April 5 to May 15, the 25th of March being entirely too early. It is suggested that the fine for a violation of the close time be 2000 pounds sterling. —2 *A*, *December* 19, 1874, 474.

FISH CONSUMPTION OF WASHINGTON IN 1874.

The report of Mr. C. Ludington, Food Inspector to the Board of Health of the City of Washington, gives a very interesting account of the consumption of animal food in a great city, and it is much to be desired that similar statistics be supplied for such points as New York, Boston, Philadelphia, Baltimore, Cincinnati, Chicago, St. Louis, etc. In respect to fish, it appears that for the market of Washington alone, during twelve months from Sept. 30, 1873, to Sept. 30, 1874, the following numbers were inspected:

Shad	628,687	Sturgeon	919
Herring	6,567,240	Bushels of oysters	569,372
Hickory shad, or tailors	80,841	Number of clams	1,163,000
Bunches of fish	567,291	Number of crabs	297,250

The fish weighed, in the aggregate, about 11,000,000 pounds; and by far the greater proportion were derived from the Potomac River and the lower part of Chesapeake Bay. When we bear in mind the fact that Alexandria, Norfolk, Richmond, and many other places, were supplied from the same storehouse, to say nothing of the immense quantities exported to more distant points, we may realize the importance of the fisheries as bearing upon the question of national economy.

The larger portion, indeed nearly all, of these fish were anadromous species, or such as live for most of the year in the sea and obtain the greater part of their growth there, and run up into fresh water for the purpose of spawning; among them the shad, the alewife, or fresh-water herring, the rock-fish, or striped bass, etc.

According to the tables prepared by Mr. Ludington, the shad supply was about one fourth less than that for 1873; but the herring were nearly double in number. In 1874 there were 2,261,117 pounds more fish inspected than in 1873. In this report the inspector urges very strongly the

regulation of the capture of shad and herring in the Potomac River, so that none shall be taken after the first day of June, in any year, until the next regular fishing season, and also that the hauling of the seine be prohibited on Sunday at any time.—*Rept. Wash. Board of Health*, 1874.

EFFECT OF POLLUTED WATER ON FISHES.

Among the various agencies injurious to fishes in fresh-water streams are the waste products from gas-works, the creosote and other similar substances contained therein, even if in very small quantity, having a marked and destructive effect; and even where the percentage is not sufficient to cause death, or apparently to affect the health of the animals, it imparts a disagreeable taste, readily perceptible, especially in the case of oysters and clams, and even of fishes.

An appeal was recently presented by the fishermen of Munich to the government in reference to the admission of gas-water into the River Isar, and its influence upon the fishes of that stream. Professor A. Wagner, an eminent chemist, was instructed to investigate the matter and make a report upon it. His article has lately appeared in the *Bayerisches Industrie- und Gewerbeblatt*, in which he describes a number of his experiments. For this purpose he introduced small fishes into vessels containing well-water, different amounts of gas-water being added. The results were as follows:

In water to which one per cent. of gas refuse was added, the fish put into it became at once very restless, tried to jump out, turned on their backs after they had been in the water one minute, and were dead after the lapse of six minutes. In water containing one half per cent. of gas refuse, fish became at once restless, floated on their backs after five minutes, and died in thirty minutes. In water to which one quarter per cent. of gas refuse had been added, fish became restless after some time, floated on their backs in one hour, and were dead after an hour and a half. In water containing one tenth per cent. of gas-water, the fish remained quiet; one of them showed no change after three hours and a half, but died after the lapse of six hours; no change was noticed in the case of another, a small pike, after seven hours, but it was found dead the next morning.

To reduce the injurious effect, therefore, of gas refuse on fish, Professor Wagner recommends that instead of emptying barrels containing about thirty cwt. of gas-water into the river at once, as hitherto practiced, it should be slowly run into it in a thin stream, so as to effect the running in of the quantity produced during the day in the twenty-four hours, the stream never exceeding five quarts, nor being less than one quart, per minute. By this means these small quantities would at once be diluted to such an extent as to become comparatively harmless, chemical decomposition of their elements in the river-water setting in at the same time, and the injurious influence need no longer be feared.—2 *A*, *Oct.* 17, 1874, 293.

MENHADEN OIL AND GUANO.

The great magnitude of the interest connected with the manufacture of oil and guano from the menhaden has, as in other cases, induced the formation of an association for mutual protection, under the title of "The United States Menhaden Oil and Guano Association." The statistics of capture of menhaden and the manufacture of oil and guano are shown by the following table:

	Barrels.
Number of fish caught during 1874	1,478,634
Number of fish caught during 1873	1,193,100
Making an increase of	285,534
	Tons.
Amount of guano in 1874	50,976
Amount of guano in 1873	36,290
Increase for 1874	14,686
	Gallons.
Quantity of oil manufactured in 1874	3,372,837
Quantity of oil manufactured in 1873	2,214,800
Increase for 1874	1,158,037

The number of barrels, as given above, would be equal to the following number of fish:

Fish caught in 1874	492,878,000
Fish caught in 1873	397,700,000
Increase in 1874 over 1873	95,178,000

The amount of oil on hand at the beginning of the year was 648,000 gallons, and 5200 tons of guano remained unsold. The number of fishermen returned for 1874 was 1567;

the number of men employed at the manufactories, 871; the number of sailing-vessels employed, 283; steamers, 25. There is a capital of $2,500,000 invested in the business, with 64 factories. A market has been found in the West Indies and in England for the guano.

HYBRID FISH.

Dr. L. J. Fitzinger has been prosecuting some experiments upon the bastard forms of *Salmonidæ*, now so extensively cultivated in the fish-breeding establishments of Germany, and which, as is well known, attain to maturity and produce completely formed eggs. However, as the result of a careful series of experiments, he ascertained that, under artificial impregnation, these eggs never develop beyond the period of the formation of the eye specks, after which they speedily perish. The hybrids upon which the experiments were prosecuted were obtained from the female trout (*Trutta lacustris*) and the male saibling (*Salmo salvelinus*), and from the female saibling and the male trout (*Trutta fario*). He thinks that the infertility of the eggs from these hybrids may be considered as an established fact. In the same article reference is made to what is called the Silver trout, or *Salmo Schieffer-Mülleri*, and the opinion expressed that this is a sterile form, but that it is impossible to say from what species it is derived or whether it is constant.

EXPERIMENTS WITH YOUNG MAINE SALMON.

In the winter of 1872–73 a number of eggs of the Maine salmon were presented by the United States to the State of Wisconsin, and hatched out at Waterville by Mr. H. F. Dousman, an experienced fish-culturist of that place. The greater portion of these were distributed by him in various rivers of the state, a few, however, being left in his ponds. On the 2d of December, 1874, in taking out his trout for the purpose of collecting the spawn, he found three salmon in the races, one female and two males. These were all ripe, and he obtained from the female about two hundred eggs, and impregnated them with the milt from the males. These eggs he has placed in a separate inclosure, and proposes to ascertain whether they will hatch out, and, if the young can be reared to maturity, what their character will be. The female was

about five inches in length, one of the males eight, and the other seven. Their average weight was about three ounces, which is considerably less than that of the trout with which they were associated.

INCREASE OF ENGLISH FISHES IN TASMANIA.

In illustration of what may be done in the way of multiplying food fishes in new localities, we may refer to the results of experiments made in Tasmania in connection with the English trout and the English perch. In four successive years prior to 1861 attempts were made to introduce these fishes into Tasmania from England, but it was not until December, 1861, that a fifth attempt succeeded. A certain number of live fish having been brought out and placed in ponds expressly built for them by Mr. Allport, other fish were obtained in the following year, from which the immense supply now so extensively distributed throughout Tasmania and Australia have been derived. The present abundance may be estimated from the fact that, in Lake Wendouree, at Ballarat, no less than nine tons were caught during the last season. One fish, three years old, weighed three and a half pounds; another, taken in 1874, weighed four pounds. The parent fish were first brought from England to Tasmania, and afterward from the latter country to Victoria. Five small fishes represent the ancestry of the fish referred to as existing in the last-mentioned country.—*Pr. Zool. and Acclim. Soc. of Tasmania for* 1874, p. 44.

STOCKING THE RIVERS ON THE WEST SIDE OF LAKE CHAMPLAIN BY THE U. S. FISH COMMISSION.

The United States Fish Commission has recently completed a very important undertaking in the interest of the State of New York, in the way of stocking the rivers of the state on the west side of Lake Champlain, especially the Chazy, the Salmon, and the Saranac, with salmon, some 200,000 in number having been hatched out at the establishment of Messrs. Stone & Hooper, at Charlestown, New Hampshire, and planted by Dr. M. C. Edmunds, one of the Fish Commissioners of Vermont.

The entire expense of this enterprise, amounting to nearly four hundred dollars, has been met by the United States.

It is well known that salmon formerly abounded in Lake Champlain and its tributaries on both sides, and, with a view of determining whether the same condition of things can be restored to these waters, this experiment has been made.

DISTRIBUTION OF TROUT EGGS FROM TASMANIA TO THE NEIGHBORING COLONIES.

The Society of Arts refers to an official report in regard to the acclimatization of trout in Tasmania, which states that in 1873 a total distribution of 4050 trout eggs was made from the rivers of that country to the neighboring colonies; 800 of these were sea trout, the rest being those of the brown trout.—23 *A*, *June* 11, 1875, 664.

IMPORTATION OF THE GOURAMI INTO PARIS.

A Paris journal announces the arrival in that city, in November last, of forty-eight gourami fish, sent to M. Carbonnier, the well-known dealer in aquarial supplies, and who has made a specialty of importing fish of this character. This gentleman now has seventy specimens in all, in thriving condition. The fish is warmly recommended for introduction into the hotter parts of the United States, especially South Carolina, Western Florida, and other sections where ice and frost are unknown.

Their special merit consists in their being fresh-water fish, of large size and great excellence of flesh, that feed entirely on vegetable matter, so that if placed in a pond with plenty of aquatic plants around them they will live and thrive without requiring any artificial means.—10 *B*, *Dec.*, 1874, 770.

FRENCH METHOD OF OYSTER CULTURE.

M. Crugny announces in *Les Mondes* that, after ten years of groping in the dark in the treatment of the great oyster banks of France, especially of Arcachon, these have entered upon a career of fertility so prodigious that Arcachon alone will soon be able to furnish oysters for the whole world, and at prices much lower than those which at present prevail. It is well known, according to Crugny, that each oyster produces, every year, spat sufficient to furnish 4,000,000 of young, but that innumerable sources of destruction greatly reduce the

yield. At the present time, in the light of more recent experiences, spat is collected on tiles previously coated with a sticky composition, to which it strongly attaches itself; while the slight adherence of this composition to the tile permits the introduction of an instrument which easily detaches the young oyster without injuring it. The spat, when it has acquired the size of a quarter-franc piece, is placed in wooden boxes covered externally with zinc, the upper opening of which is closed by a wire network of close meshes. After the oysters have increased in this inclosure, protected from every external attack, they are placed in large ditches, excavated either by the hand of man or by nature, in which at low tide there is always a sufficient depth of water to protect the young shells against the severities of the winter or the heats of the summer. Thanks to all these precautions, the oyster-culturists in France have lately been able to save a large part of their crop, and can soon, if nothing interfere, furnish excellent oysters at a cheap price.—3 *B*, *Nov.* 26, 1874, 516.

MR. C. G. ATKINS'S EXPERIMENTS ON THE ARTIFICIAL HATCHING OF THE SMELT.

Among the recent novelties in fish-culture may be mentioned the experiments made by Mr. Charles G. Atkins, at his establishment in Bucksport, Me., on the artificial hatching of the eggs of the smelt. It is not a new thing to transport the parent fish from one locality to another, and thus cause their multiplication, but Mr. Atkins is the first actually to take the eggs, impregnate them by artificial means, and bring their hatching to a successful termination. The particular variety treated by him is what is known as the *Belgrade* smelt, a fresh-water and land-locked species found in the Belgrade River, in Maine. It attains a very large size (for a smelt), its weight sometimes amounting to nearly a pound, and with a length of ten or twelve inches; these dimensions being, as the experienced will readily understand, very much larger than the ordinary smelt. The difficulty in hatching the eggs of this fish lies in the fact that they are adhesive, instead of being dry, as in the salmon and shad. They are covered with a tenacious mucus, which causes them to stick to the first object they touch, and prevents their treatment by the

ordinary method. Mr. Atkins, however, causes them to drop upon twigs, pieces of cocoa-matting, etc., and then subjects them to the fertilizing influence of the male. He in this way obtained about a hundred thousand from each female, the time of hatching extending over nearly a month. The young are hardy and vigorous, and will probably require five or six days for the absorption of the yolk. Mr. Atkins thinks that the conditions of success in treating the hatching of carp artificially are those which have just been mentioned, and, in addition, a strong current for the hatching and development, together with the avoidance of all jarring.

SETH GREEN'S ARTIFICIAL HATCHING OF STURGEON.

A very important experiment has just been made successfully by Seth Green on the artificial hatching of sturgeon, a subject to which he has had his attention directed for some years, but which he has not been able to carry into actual effect until 1875. No details of his experiment have yet been published; but it is understood that he has found little difficulty in breeding them, and that he has turned many thousands into the Hudson River.

The sturgeon is a very valuable fish, the flesh being not only excellent when fresh, but particularly nice when smoked. The caviare and isinglass obtained from the fish constitute important elements of its value, both of which are now manufactured in various parts of the United States on a large scale.

An incidental effect of the experiments made by Mr. Green will be the policing of the Hudson River, and keeping it free from the shad seines which now prevent the upward movement of the fish. Another season the sturgeon will probably encounter these nets, tearing them to pieces in their passage.

THE NEW WESTMINSTER AQUARIUM.

Among the magnificent aquaria lately started in Europe, that of "The Royal Aquarium and Summer and Winter Gardens" at Westminster, now in process of erection, promises to be the most notable, embracing as it does in its construction the best features of the other establishments and omitting their imperfections. In size, too, and resources, it

bids fair to outrank all the others. The building on Tuthill Street is 545 feet long, from 160 to 240 feet broad at the broadest part, and 80 feet where narrowest, the height being from 60 to 80 feet. On the ground-floor is a spacious promenade, and the tanks are placed around half its length on the north side, and nearly the whole of the length of the south side. These are 31 in number: two containing about 40,000 gallons each, one of 12,000, twelve of 4000 gallons each, two more of 1400 gallons, and fourteen each of 270 gallons. In addition there will be twelve others, not for public exhibition, but for reserve or hospital purposes, each containing about 400 gallons. The largest fifteen tanks are of masonry, forming part of the building itself. The smaller ones are of slate. The fronts of all are of plate glass, of which there will be about 2000 square feet one inch thick, and 500 feet half an inch thick, all toughened by De la Bastie's process.

Every water receptacle not made of slate is to be lined with asphalt, and all the pipes are so placed as to be easily accessible for examination for leakages. Beneath the floor of the promenade is an enormous reservoir, looking like three railway tunnels, arched above and below, and holding in all about 700,000 gallons; and from this the water will be pumped into the tanks above at the rate of from 15,000 to 30,000 gallons per hour day and night incessantly. To guard against the stoppage of the current from accidents to the machinery, the steam-engines and boilers are doubled. The boilers are much larger than needed by the steam-engines, as the former will be used also to warm the building in winter. The water in the tanks will take its temperature from that in the reservoir, and always at a mean between that of the surrounding air of summer and winter. There are eight pumps—four for sea and four for fresh water; and these pumps, with all pipes, taps, valves, gratings, and jets, are to be of vulcanite or hard India rubber. Metal in any form would corrode in time and gradually poison the water, which it is proposed to use indefinitely without change, since, singular as it may seem, the longer a large mass of water is used for aquarium purposes the better it appears to be.

The great reservoir is divided into nine compartments,

with an arrangement to enable any one or more to be isolated and emptied for examination without wasting any water or interrupting the circulation. This, by reason of its great dimensions, and also by reason of its coolness and darkness and the absence of life in it, will keep the entire aquarium arrangement in good order, since the water will be constantly flowing in and out of it. It will travel a distance of nearly three miles between the beginning and end of its circuit, in the course of which a portion (about one tenth) will be lifted about seven feet, and be made to enter each tank with force through fine jets, which will carry air into the tanks in a finely divided state. The total quantity of water in use, including that in the proposed fountain basins, will be nearly a million gallons, of which about three fourths will be sea-water, to be brought from Brighton in casks by Mr. W. Hudson, at the rate of a railway train of twelve trucks full every day for six months.

Mr. A. Bedborough is the architect, Messrs. Lucas are the builders, Messrs. Leete, Edwards, & Norman furnish the machinery and circulating apparatus, Messrs. Doulton & Co. supply the ornamental tiles. The rock work is furnished by Mr. Wills; Professor R. V. Tuson is the chemist of the establishment, the whole being under the direction of Mr. Lloyd himself, well known from his connection with the Hamburg establishment and others which he has organized. For the proper supply of animals for this and other aquaria, it is contemplated to arrange two traveling aquaria—one for Great Britain and the other for the Continent—to convey living marine animals from the Naples aquarium, where a great variety of species can always be had. According to Mr. Lloyd, the old-fashioned plan of maintaining a proper supply of oxygen for the animals in aquaria, by the introduction of living plants, is practically inapplicable to large establishments, the true theory being that of keeping the water cool and clear, and properly charged with atmospheric air in a large, dark reservoir.

In addition to the aquarial display at Westminster, there will be a picture and fine art gallery, and accommodations for flower shows, etc. Musical entertainments will also be given. Mr. Lloyd protests against the admission of the lung-breathing aquatic animals, such as seals, porpoises, and the

like; and he proposes also to exclude all reptiles, birds, and mammals.—15 *A*, *Sept.* 18, 376.

FISH AT GREAT DEPTHS.

For the purpose of illustrating the physical conditions to which fish are exposed at great depths, M. Moreau has subjected them to a pressure of ten atmospheres in a vessel. He finds that by bringing this on gradually the fish do not experience any ill effect, but that on suddenly relaxing the pressure they die rapidly with hemorrhage, the blood becoming spumous. This phenomenon he considers due to the disengagement of the gas which the blood had dissolved in large quantity.—8 *B*, *July* 24, 96.

PISCICULTURAL PRIZES.

Among the prizes recently decreed by the Société d'Acclimatation of Paris, at its annual public session on the 7th of May, was one of five hundred francs to M. Carbonnier for the exhibition of specimens of American *Fundula cyprinodonta*, characterized as being a fish of very excellent flavor. It is difficult to understand that this fish, well known in the United States, is now considered as one of importance, there being so many others of superior size and rapidity of growth that could have been selected. As M. Carbonnier exhibited specimens born in Paris, his prize was doubled, and he received one thousand francs.

On the same occasion a medal of the first class was given to Seth Green—this in addition to the grand gold medal which he received in 1872. This last-mentioned prize was in return for the transmission to Paris during the last year of fertilized eggs of various species of salmonidæ.

The introduction of the California salmon into the Eastern United States has also been considered by the French society a matter of very great economical importance; and although not specially interested at present in the species, they have decreed to Mr. Livingston Stone a second-class medal for his superintendence of the United States breeding establishment, and also similar honors to Mr. G. H. Jerome, one of the Fish Commissioners of Michigan, and to Mr. Crouch, of Jackson, for hatching out and distributing the young of these fish in the St. Joseph, the Kalamazoo, and Grand Rivers.

Special attention is invited by the society to the California fish, and the hope is expressed that it may be ultimately introduced into the tributaries of the Mediterranean, and especially into the Rhone.—10 *B*, *May* 30, 1875, 60.

CHANGE OF WATER IN AQUARIA.

A writer upon marine aquaria remarks that the experience of Mr. Bawins, who has possessed a marine aquarium for ten years, has been that he has not renewed the sea-water contained in it during that period. All that he has done is to add fresh water as the salt water evaporates, the same degree of saltness being invariably maintained. Various species of small sea-weeds and several mollusks thrive without further care; but some species of Actinia raised in the same medium were starved to death in the absence of the owner, who had made a practice of feeding them with worms and even raw meat.—12 *A*, *June* 10, 116.

FRENCH PRIZES FOR AMERICAN FISH.

North America possesses an enviable superiority over most parts of the world in the number and variety of fresh-water fishes capable of being multiplied artificially for the service of mankind, having species corresponding to nearly all those known elsewhere, and several forms entirely peculiar to its own waters. Thus while its wall-eyed pike, or pike-perch, is equivalent to the much-esteemed sandre, the yellow perch to a similar species in Europe, the striped bass, or the rock-fish, to the European bass, it has in the black bass and the large variety of smelt, the trout, whitefish, and the California salmon, forms whose introduction into Europe is very desirable, to say nothing of the shad and alewife.

Recognizing this fact, the authorities of the Paris Société d'Acclimatation have offered prizes of five hundred francs, respectively, for the introduction into France of our common brook-trout, of the Otsego bass, the California salmon, and the black bass, on the condition that the imported fish survived for more than a year. If young fish bred from these parents can be exhibited, then the amount of the prize in each case is to be doubled. The prizes in regard to the trout and black bass were open till the 1st of December, 1875; those

for the Otsego bass and California salmon remain open until the 1st of December, 1880. A prize of two hundred and fifty francs was open until the 1st of December, 1875, for the multiplication in France of the American bull-frog, this conditioned with the exhibition of at least twenty-five specimens born in France.—10 *B*, *May* 30, 1875.

FISH-CULTURE IN CHINA.

According to M. Renaud, the method adopted by the Chinese for raising the cyprinoid fishes, such as the carp, tench, etc., is by placing them in large earthen vessels, some hundreds of gallons in capacity, filled with fresh-water plants. When the spawning season arrives, which is known by the disturbance of the water in consequence of the rapid movements of the fish, the eggs, which are deposited on the plants, are removed by means of a skimmer, and placed in the shade in a vessel with a flat bottom and about four inches in depth. The hatching takes place at the end of about eight days, and after the yolk-bag is absorbed, numerous minute embryos of insects, crustaceans, etc., found in stagnant water, are obtained from the surface with gauze nets, which are then washed off in the water containing the young fry. At the end of six months these attain the dimensions of about an inch in length, after which they may be turned into the vessels in which are the larger fish.—10 *B*, *June*, 294.

NEWFOUNDLAND FISHERIES IN 1874–5.

By the report of the Chamber of Commerce of Newfoundland for 1874–5, we learn that the Labrador cod-fishery was of an average catch, and that the Labrador herring-fishery during the fall of 1874 was unusually productive. The seal-fishery, however, was entirely unsatisfactory, with very few exceptions, the sailing-vessels being unsuccessful, owing to the enormous quantity of ice packed on the coast, and the unusually severe weather. The catch by the steamers was better, and the seals were taken in a much more mature condition than those captured last year.

The export of cod-fish for 1874 was very large, having reached the enormous total of 1,609,724 quintals, being a large increase over that of 1873. The present condition of

the shore fisheries for the season of 1875 is unsatisfactory, the capelin, the bait used for taking the cod-fish, having remained but a short time, and, when obtained, being but slightly attractive. It is hoped that when the squid come in the fishery will be more successful. Several vessels are now employed exclusively in capturing squid to be furnished to the fishermen, and their operations have been prosecuted to such an extent as to induce some fear of the failure hereafter of the supply of this important animal.

ILLUMINATION FOR ATTRACTING FISH.

Among the articles exhibited at the International Maritime Exhibition at Paris was an arrangement for producing light under water, consisting of a platinum wire placed in a bottle, and ignited by electricity from a bichromate battery. It is said that experiments tried by this apparatus on the coast of France proved very satisfactory, attracting large numbers of fish, sardines especially.

A somewhat similar arrangement was proposed some years ago in the United States, in which, after the fish are brought near enough, a vortex of water is to be produced by a steam-pump, which, in spite of resistance, draws them into a trap, until this becomes entirely full. We have not learned whether any experiments were ever made with such an apparatus.—12 *A*, *Sept.* 2, 388.

MANUFACTURE OF COD-LIVER OIL.

The production of cod-liver oil in the United States and the British Provinces is carried on at present on a very large scale, the greatest amount being prepared at St. Johns, Newfoundland, from its proximity to the great fishing-banks. The process of producing this oil is very simple, consisting in first carefully washing the livers until every trace of gall and foreign matter is removed, after which they are placed, with a little water, in a specially contrived boiler, and heated to a temperature of 112°. The livers swell and finally burst, when the oil contained in them rises to the top, and is at once skimmed off. This portion of the operation must be performed in as short a time as possible, so that the oil may rise and be removed before the livers have time to break up and mingle with it. One cause of the offensive taste and

smell that cod-liver oil sometimes exhibits is from the mingling of very minute pieces of the liver with the oil, which afterward putrefy in it. After being skimmed off, the oil is boiled until the water is evaporated.

The next operation is that of filtering, which is continued at least four times, the last filter being of the finest muslin, which extracts all traces of sediment. The resultant liquid, provided the livers were not more than twelve hours old, resembles Sauterne wine in appearance, and is almost entirely devoid of color, taste, and smell.

The usual yield of oil is given as about one gallon to the quintal of livers. Owing to the low temperature at which the oil is extracted, fifteen months is the longest time it will keep sweet and retain its original flavor; after that time various ingredients are mixed with it which preserve it, or rather disguise its rancid taste.

In some localities in America the process of steaming is resorted to, which is supposed to facilitate the operation and improve the product.

OPERATIONS OF THE UNITED STATES FISH COMMISSION IN 1875.

The operations of the United States Fish Commission for the year 1875, so far as the hatching and distributing of shad were concerned, closed at the end of July, after a very successful season. The work was commenced in April, on the Neuse, in North Carolina, and continued subsequently on the Pamunky, the Rappahannock, the Potomac, and the Delaware; but, owing to the extremely small run of shad in these streams, very little was accomplished. With the assistance of the New York State Commission, a small supply of young shad was obtained at Castleton, on the Hudson; but even here the run of shad was very poor, being much below that of previous years. The indifferent luck of the season was, however, changed after commencing operations at Holyoke, on the Connecticut, about the 1st of July, where, under the direction of Mr. James W. Milner, the Assistant Fish Commissioner, a very extensive hatching and distribution was initiated, the work extending satisfactorily throughout the month. Here the entire expense of hatching and distribution was borne by the United States, the

agreement made by the United States Commissioner with the fishery authorities of Connecticut and Massachusetts being to put half of all the fish hatched into the Connecticut River, one fourth of this number to be sent up the river to a considerable distance.

The total number of fish hatched at this station was about 3,370,000, of which 2,000,000 were turned loose into the Connecticut, the shipments to other rivers amounting to 1,370,000, those from the Hudson and Delaware being only 625,000. Of the fish sent from the three rivers, 755,000 were placed in the tributaries of the Mississippi, 280,000 in streams that empty directly into the Gulf of Mexico, and 560,000 in rivers (other than the Connecticut) which empty into the Atlantic. The waters of nearly every state east of the Missouri have been benefited by the shipments made during the season. There can be no question that this large and widespread distribution of fish will have a very important bearing upon the solution of the problem of stocking the waters of the United States with useful food fishes. It must be borne in mind that the advantage of the artificial hatching of fish over the natural spawning consists not merely in the ability to plant the fish where it is desired to have them, but also in the much greater success of the work. It is generally estimated that not more than one egg in a thousand (if so many) of those naturally spawned produces a young fish able to provide for itself. In artificial hatching, however, of one thousand eggs taken there is a probability that at least nine hundred, or even more, will reach the above-mentioned stage; so that, instead of counting upon the proceeds of 4,000,000 eggs under ordinary circumstances, we should have those of 3,600,000,000. Included in the number of eggs collected at Holyoke were 400,000 shipped to Germany on the 17th of July, which were placed in a special apparatus for hatching while on the voyage. We regret, however, to learn that the experiment, like that of last year, was unsuccessful, the eggs perishing before reaching their destination.

SALMON IN THE SAN JOAQUIN.

The question of the possibility of cultivating the California salmon in the warm waters of the Eastern United

States has been very satisfactorily answered by a recent communication of Mr. P. B. Redding, one of the Fish Commissioners of California. This gentleman reports that on the 15th of last August salmon commenced running up the San Joaquin River, passing the bridge across that stream, in latitude 36° 30′, longitude 120°, in large numbers, appearing in size and general character identical with the Sacramento fish. At that point they must have passed for one hundred and fifty miles through the San Joaquin Valley, in which the mean temperature of the air at noon, in the shade, for the summer, has been about 104°, the temperature of the water at the surface from 80° to 86°, and that at the bottom from 75° to 80°. The mean depth of the river has been found to be four feet seven and three-eighths inches.

It is very doubtful whether this water temperature is exceeded in any part of the United States; certainly not in any of our larger rivers, nor in such as would be suitable for the existence of the California salmon.

It is well known that the Eastern salmon becomes uncomfortable when the temperature of the water reaches 65°, while a higher degree of temperature drives them back to the sea in search of cooler quarters.

SALMON TRADE OF THE COLUMBIA RIVER.

The salmon trade on the Columbia River during the season of 1875 has been one of remarkable prosperity, the unfavorable indications at the outset not having been continued. Of fourteen canning establishments on the river, twelve were in operation, and put up in all 275,000 cases, each case containing four dozen one-pound cans, the largest number being put up by A. Booth & Co., at Astoria, or 34,000 cases. A large quantity of fish has also been packed in tierces and barrels, the weight of which has not been given.

An important addition has been made to the usual treatment of these fish in the utilization of the heads for the purpose of extracting the oil, about nine thousand gallons having been obtained by Messrs. Watson & Co., of Manhattan, which was put up in five-gallon tin cans. It is probable, too, that the offal generally will all be used ultimately for oil and manure. The prices so far realized for the salmon

have been better than in 1874, amounting to from $1 30 to $1 35 per dozen this year, as contrasted with $1 05 per dozen last year.

MARKED SALMON.

It is the custom at the United States salmon-hatching establishment at Bucksport, Maine, under charge of Mr. Charles G. Atkins, after stripping the spawn and milt from the fish, to return them uninjured to the sea. Each fish is, however, generally marked with a platinum tag, so that it can be identified if it return. An extra price is offered to fishermen for any of these tagged salmon. During the present summer no less than seven of the fish so marked in November, 1873, were received by Mr. Atkins. Unfortunately, however, only the wire band remained, the tags having been worn off or destroyed in some manner. These were all females, in good condition, and well provided with spawn.

SALMON IN THE SACRAMENTO RIVER.

The run of salmon in the Sacramento River during the season of 1875 has been something unprecedented, Mr. Livingston Stone, in charge of the United States salmon-hatching station on the M'Cloud River, stating, under date of August 26, that, in a space of about a hundred yards by thirty, five thousand salmon per hour could be seen jumping out of the water. Mr. Stone has actually counted one hundred in a minute, and has seen eighteen spring out of the water at once.

ANIMAL INCRUSTATION ON THE GREAT EASTERN.

Mr. Henry Lee, in *Land and Water*, gives an interesting account of his visit to the *Great Eastern*, for the purpose of obtaining marine animals for the Brighton Aquarium from the ship's bottom, which was about being cleaned of a vast accumulation of organic matter. The principal mass of adherent substances consisted of mussels, forming one dense deposit covering a surface of fifty thousand square feet of iron plates, and in some parts six inches thick. On the basis of an allowance of twelve pounds of mussels to the square foot, which was considered very reasonable, it was estimated that no less than three hundred tons were at-

tached—enough to load two colliery brigs with full cargoes.—2 *A*, *Aug.* 21, 140.

PHYSICAL CONDITION OF THE HERRING-FISHERY.

The Scottish Herring-fishery Board undertook in 1874 a series of experiments in reference to the physical agencies that affect the salmon-fisheries of Scotland, including a determination of the temperature of the sea by means of deep-sea thermometers at the time and place when fishing was going on. Mr. Buchan, secretary of the Meteorological Society, who has recently analyzed these observations, reports that although the returns are not sufficiently full to afford any accurate rule, owing to the lateness of the period before the sea thermometers were ready to be sent to the fishermen, they prove that "during the periods when good or heavy catches were taken, the barometer was in the great majority of cases high and steady, the winds light and moderate, and electrical phenomena wanting; and, on the other hand, when catches were low, the observations often indicated a low barometer, strong winds, unsettled weather, and thunder and lightning." From the complete returns of the daily catch of fish and of the meteorological conditions, inclusive of the temperature of the sea, now obtained, it is anticipated that materials will be collected in three or four years from which most valuable conclusions will be arrived at.

FOOD FOR TROUT.

Dr. Middleton Goldsmith, the well-known Fish Commissioner of Vermont, residing at Rutland, has lately satisfied himself that trout can be readily fed and reared on corn-bread, the experiment having now been conducted by him over a period of several years with perfect success. He thinks that trout are much healthier and of better flavor when thus fed, although they do not grow so fast as when provided with animal food. There are also fewer cases of diseased fish, and they are much less liable to the attacks of the white fungus—which fastens upon any abraded surface, and soon destroys the fish—than when fed upon meat. It is quite probable that this fungus (from which fish in a natural state are generally free, and which is the pest of all

fish-raisers, having been known to destroy many thousands of pounds of fish in a single season) may be the result of some unexplained agency or influence of cooked meats such as are usually fed to trout, and allied to scurvy. If, therefore, the change to a vegetable diet will prevent its occurrence, it will be a very important fact.

Dr. Goldsmith advises corn-bread, as being the least expensive, but finds that any other bread will answer.

ELECTRICAL FISH-BAIT.

Among the novelties in the late Paris Maritime Exhibition is an electrical fish-bait. It consists of a wire of platinum placed in a bottle of dark-colored glass, and made luminous by electricity from a bichromate battery. When thrown into the water the light emanating therefrom is said to attract immense numbers of fishes.

UNITED STATES SALMON-HATCHING ESTABLISHMENT.

The operations during the season of 1875 of the United States salmon-hatching establishment on the M'Cloud River, a tributary of the Upper Sacramento, under the direction of Mr. Livingston Stone, have been conducted with great vigor and with wonderful success, upward of 9,000,000 eggs having been obtained, of which 6,210,000 were sent East in good condition. The remainder have been kept in the hatching-house at the camp, to be developed and placed in the Sacramento River.

The eggs were packed in 156 packages, each two feet square by six inches deep; 80,000 eggs were placed in each box, in layers properly separated by damp moss. They were then packed in crates in pairs, surrounded by stuffing of some kind to prevent jarring. Several different substances were used for this purpose, as moss, hay, and ferns, in order to determine which material is best adapted to the purpose.

The total weight of the consignments amounted to over 20,000 pounds. The bulk of the eggs alone, without the packing, was 80 bushels; 150 bushels of moss were required for packing.

So far as heard from, the eggs sent East during the present season have all arrived in good condition, with very

trifling loss, the result being more satisfactory in this respect than in any previous year.

It is probable that nearly three times as many young fish will be hatched out and planted in the waters as were procured in 1874. Between two and three millions of eggs still remained at the establishment on the M'Cloud River on the 14th of October, when the shipments were completed, their hatching and planting in the Sacramento being provided for by some public-spirited citizens of California, among them Governor Leland Stanford, Mr. Crocker, and others.

NEW FISH PRODUCT.

In the fishery division of the Danish agricultural display held not long since at Biborg, in Jutland, a new fish product was exhibited by Möller, in the form of fish-sausage. This consisted of finely chopped salted fish, with an addition of pork and spices, and constituted a very acceptable article of food.

REPORT OF THE FISH COMMISSION OF VIRGINIA.

The annual report of the Fish Commission of Virginia, under its new organization, for 1875, has been published. The Commission is now composed of Mr. A. Moseley, of Richmond, Dr. W. B. Robertson, of Lynchburg, and Professor M. C. Ellsey, of Blacksburg, who have been extremely active in the discharge of their duties, although with a very limited appropriation at their command. The report is very creditable to them, and shows a comprehension of the problem to be solved in regard to the protection and multiplication of food fishes in Virginia. As might have been expected, the shad and the striped and black bass received special attention on their part. Much also has been done in regard to the introduction of the California salmon, that fish of the future. They obtained a large number of the eggs from the United States Fish Commission, for which they established two hatching-houses—one at Blacksburg College and the other at the Virginia Military Institute; and they propose to have others hereafter at the University of Charlottesville and at the Hampden School, at Hampden, whenever their funds will permit. The young fish will probably be soon introduced into their new quarters in appropriate streams

in Virginia. The Commissioners also did what they could toward propagating the shad, although the season was unfavorable for the fullest measure of success.

INSPECTION OF FISH IN THE WASHINGTON CITY MARKET.

The annual table of the inspection of fish in the Washington city market has just been presented to the Board of Health by Mr. C. Ludington, Inspector of Marine Products. From this we learn that the number of shad inspected amounted to 464,215; of tailors (a species of shad), to 56,430; and of herring, to 1,674,465. The number of "bunches of fish" sold was 557,203; of sturgeon, 1240; the whole of which, reduced to pounds, is equivalent to 7,002,049. Of oysters there were 305,737 bushels; of clams, 1,110,725; of crabs, 446,525.

This table, as compared with that of 1874, exhibits some notable differences. Of shad scarcely more than two thirds as many were marketed as in 1874, and about one half of the number in 1873. Herring showed a still greater diminution, the yield in 1874 having been 6,567,240. The "bunches of fish" were about the same. On the other hand, the yield of sturgeon was much greater, being nearly three times that of 1873, and thirty per cent. more than that of 1874.

The total yield of fish, in pounds, in 1873 was 8,548,851; in 1874 it was 10,827,967, that of 1875 being a very noticeable diminution from the yield of the previous year. Of oysters and clams a considerable less number was marketed in 1875, but a larger number of crabs.

Some idea of the importance of a careful inspection of the fish in the market may be learned from the fact that the value of the fish condemned as unfit for food in 1875 amounted to over $7000; in 1874 to over $10,000.

It may be remarked that by far the greater portion of the fish sold in the Washington city market is derived from the Potomac River and Chesapeake Bay, as may also be said of the oysters, clams, and crabs. The inferiority in the number of shad and herring taken in 1875 is supposed to have been due to the continued cold weather during the spring, which prevented the waters from attaining a temperature such as would invite the expectant fish to enter the rivers

from the sea. The yield in the Delaware, the Hudson, and the Connecticut was larger than usual, thus explaining what became of the difference.

SEVENTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW YORK.

The seventh annual report of the Commissioners of Fisheries of the State of New York, transmitted to the Legislature February 1, 1875, contains a great deal that is interesting and useful in connection with the measures for supplying the rivers and lakes of the United States with food fishes. A noteworthy feature of the report consists in the large number of embellishments it contains, such as the New York shad-hatching camp and the method of taking the spawn from the fish; plates representing the black bass, the salmon-trout, the brook-trout, and the true salmon, showing the appearance of some of them at different ages. There is also a plate representing the typical shad-hatching box, as invented by Seth Green.

Under the head of "Shad Hatching," the Commissioners report the hatching and turning into the Hudson River in 1874 of over 5,000,000 young shad; and they announce that the yield of mature shad for the past year has been 100,000; showing a steady increase in the number from year to year. They state that larger hauls were made in the nets last season than have been known for many years, and that the fish have been every where more abundant, this being accompanied by a corresponding fall in price, the prevailing rates being one third of those that had ruled previously. They think, however, that if they could procure a much larger number of spawning shad, they could accelerate the period when the price shall be as low as was ever known in the country, and they attribute their difficulties in procuring these to the great number of stake nets stretched across the river at many points from its mouth up to Albany, which thus impede the movements of the fish. They earnestly urge that a close time be established, of at least from Saturday night until Monday morning, during which no fish shall be taken, and the nets shall be raised, under a very severe penalty.

The shad-hatching season of 1874 commenced on the 18th

of May, and terminated on the 1st of July, making a period of about six weeks.

The Commissioners, after a careful consideration of the facts, are decidedly of the opinion that the experiment of introducing shad into the great lakes has been a success, and that there is every reason to believe that when deposited in the rivers the young will mature in the lakes and return to their starting-point.

The distribution of black bass, which has been going on for several years, has been continued during 1874, amounting to 365 in number; of the Oswego bass, 533; while 1279 of other allied species have been sent out. These operations have already resulted in a greatly increased yield in the general fisheries of the state, so that lakes where nothing could be taken but a few years ago now furnish satisfactory fishing to many persons.

In regard to other fish, the Commissioners report the addition of 527,000 whitefish, and 180,000 salmon-trout, with a large number of eggs sent to many parties who desire to make experiments upon them. The Commissioners speak in terms of approbation of the efforts now making on the part of the United States to introduce the California salmon into such waters as are not suited to the species of Maine, and cite several instances where the young have been taken after introduction into the streams of New York, showing surprising vigor and rapidity of growth.

The report contains some reference to the action taken by the Commissioners in regard to the propagation of the grayling, and they think that the addition of this species may be one of some practical importance, as it certainly is a matter of much interest. A considerable portion of the report is devoted to the consideration of the injurious effect of pound nets and other modes of trapping fish, and they strenuously urge the passage of laws to prohibit their use entirely, or at least to regulate their employment at certain seasons and in certain localities. They point particularly to the use of these nets in the great South Bay of Long Island, where, in their opinion, in consequence of the multiplication of nets within the last few years, line fishing has been almost entirely destroyed.

In conclusion, the Commissioners state that, without re-

laxing their efforts in regard to other fish, they purpose now to devote more attention to hatching and distributing the brook-trout. Their establishment at Caledonia has an almost unlimited capacity, and they think they will be able to supply trout spawn or young trout, in a certain number at least, to almost all applicants, and that in this way a great addition to the food resources of the state may be secured.

GLOUCESTER FISHERIES IN 1875.

The average valuation of fish landed at Gloucester during the year 1875 was as follows: 177,473 quintals of Bank codfish, $998,628; 185,758 quintals of Georges codfish, $1,021,669; 4258 quintals of hake, $12,764; 2349 quintals of cusk, $7047; 9417 quintals of pollock, $32,964; 2,462,864 lbs. of Georges halibut, $172,365; 7,248,423 lbs. of Bank halibut, $507,388; 38,292 bbls. of herring, $153,168. Total, $2,905,994. This does not include the amount of shore fishery.

FISHERIES OF THE ARCTIC REGIONS.

Captain Adams, of the whaler *Arctic*, arrived at Dundee on the 6th of November from the Davis Strait's fishing. From the condition of the wind and sea at Carey Island he believes there must have been a vast extent of open water toward the north, which would permit the British arctic expedition to reach a higher latitude than possibly could have been done at any time within many years past.

FAILURE IN INTRODUCING SALMON AND TROUT.

An attempt has lately been made to convey the fry of trout and salmon from England to Australia by the Peninsular and Oriental Company's steamers, the route of which is by the Suez Canal; but without success. The experiment proceeded satisfactorily until the Red Sea was reached, when the mortality commenced, and on the twentieth day out the whole of the fish were dead.

GROWTH OF OYSTERS IN FRANCE.

A correspondent of *Land and Water* refers to recent operations conducted in France for the multiplication and growth of oysters, remarking that the process of culture is quite dif-

ferent from that in England, and not so expensive. At Arcachon tiles are used, to which the spat attaches itself when floating about the bay. Walls about eighteen inches high are made of the tiles on the mud-banks, which retain the water when the banks are dry at low tide. In these ponds the young oysters are kept after they are taken off the tiles.

At Auray the collectors of spat used are tiles, wooden boards nailed together, and slates. The wood seems to answer admirably well.

At L'Orient the apparatus of cultivation consists of what are called Michel's Patent Concrete Pans. These are about two and a half by one and a half feet, and eight inches deep, retaining the water when the tide is out. The young oysters remain in these pans, and the growth made in one year is very remarkable. The temperature of the water at L'Orient was sixty-eight degrees.

YARMOUTH AQUARIUM.

The new aquarium at Yarmouth, England, it is said, will be completed by June, 1876. Mr. Saville Kent, at present in charge of the Manchester aquarium, has been appointed manager and naturalist of the new establishment.

K. DOMESTIC AND HOUSEHOLD ECONOMY.

TRANSPARENT SOAP.

The most essential condition in the preparation of transparent soap, and one frequently overlooked, is that the soap employed shall be as nearly neutral as possible, as any free fatty acid present separates subsequently in clouds and flakes; while free soda, on the other hand, attracts carbonic acid from the air, forming crystals of carbonate of soda. The transparency of glycerin soap is also said to be improved by the addition of a small quantity of white sirup.—15 *C*, XII., 191.

THE USE OF GAS FOR LIGHT-HOUSES.

The great advantage of employing gas for light-house purposes is stated to consist in the fact that, by a very simple arrangement, the number of burners and the brilliancy of the flame can be increased from its ordinary to an extraordinary brightness, such as to provide for its visibility in all kinds of thick weather, except, of course, that condition of fog which no light, not even the sunlight, can penetrate. In a fixed light apparatus, of any size, there is no occasion to alter the existing lenses if we wish to introduce the use of gas instead of oil; but in some lanterns it may be necessary to provide for additional ventilation. The cost of gas-light is said to be less than that of oil, while the photometric value of the flame of gas is largely superior to that of any kind of oil. When the "fog-power" of the gas-light is turned on, the cost of the gas per hour is greater; but taking the average of a year's consumption, at several light-houses, it appears that there is an actual saving of about $300 per year by the use of gas. A very simple apparatus effects an automatic intermission in the light, which not only saves somewhat in the consumption of gas, but acts as a means of distinguishing one light-house from another, precisely as is at present brought about by the introduction of the flashing system. A gas-light of the first order, employing Mr. Wigham's gas-burners of 108 jets, would, if fixed, be

equal to 70,000 standard candles; but, if revolving, be equal to 873,000 candles.—*Elliot's Light-house System*, p. 169.

PRICE OF BURNING-GAS.

The following figures show the net price of illuminating-gas throughout the United States in 1875, upon the authority of the Washington, D. C., Gaslight Company:

1. Maine	$3 87	20. Mississippi	$5 25
2. New Hampshire	3 96	21. Wisconsin	3 87
3. Vermont	4 80	22. Michigan	3 43
4. Massachusetts	3 86	23. Ohio	3 32
5. Rhode Island	3 35	24. Indiana	3 54
6. Connecticut	4 03	25. Illinois	3 87
7. New York	3 88	26. Kentucky	3 92
8. New Jersey	3 80	27. Tennessee	4 06
9. Pennsylvania	3 46	28. Minnesota	4 31
10. Delaware	3 95	29. Iowa	4 52
11. Maryland	3 59	30. Missouri	3 95
12. District of Columbia	3 16	31. Arkansas	5 00
13. Virginia	3 89	32. Louisiana	4 50
14. West Virginia	3 11	33. Texas	5 75
15. North Carolina	6 67	34. Kansas	4 55
16. South Carolina	3 80	35. Colorado	5 00
17. Georgia	5 07	36. Utah	4 00
18. Florida	8 00	37. California	6 11
19. Alabama	4 83		

Total average net price of gas in the United States, $4 32½ per 1000 cubic feet.

A NEW LIGHT.

According to *The Athenæum*, Mr. Spiller has succeeded in producing a light far better than that from nitro-oxide and the bisulphide of carbon, and free from its dangers. This is accomplished by dropping small pieces of brimstone into fused saltpetre, in a glass tube.—15 *A*, *Jan.* 30, 1875, 166.

TREATMENT OF NEW WOODEN UTENSILS, ETC.

Wooden vessels for containing articles of food, wine, etc., also wooden vessels for culinary purposes, can be rendered fit for immediate use, as to the removal of the unpleasant extractive matters, by treatment with a solution of washing-soda. Thus an ordinary barrel should be filled half full of water, and a solution of about two pounds of soda in as much

water as will dissolve it, then headed, and the liquids thoroughly mixed by shaking the barrel, which should then be filled to the bung with water, and allowed to remain for from twelve to fourteen days; then, after withdrawing the discolored liquid, it should be well rinsed and filled with pure water and allowed to remain several days, when it will be fit for use. Other wooden utensils may be treated with a similar solution of soda.—8 *C, Nov.* 26, 1874, 422.

LAMP FOR BURNING NITRIC OXIDE GAS.

The brilliancy of the light produced by the combustion of nitric oxide gas, after mixture with a few drops of sulphide of carbon, has been known for some time, and its application to photographic purposes suggested; but it is not until recently that Messrs. Delachanal and Mermet have constructed an apparatus by which it can be made practically available. They use a lamp made of a pint bottle, having two openings through the cork, and filled with fragments of some porous substance, as sponge, coke, or pumice, for the purpose of imbibing the sulphide of carbon. A tube, reaching within one fourth of an inch of the bottom, passes through one opening in the cork, and a larger one through the other opening. This is about eight inches long, and may be of glass or metal, and is closely packed around with iron-scale. The object, like that of the gauze in the safety-lamp, is to prevent the return of the flame into the bottle, and its consequent explosion. The nitric oxide gas is passed into the bottle through the first-mentioned tube, and the gaseous mixture is conducted by a rubber tube to a kind of Bunsen burner, the air-holes of which are closed, and which is furnished with a small conical valve to regulate the flow of gas. This burner is also filled with iron-scale. The nitric oxide gas is produced in the cold by Sainte-Claire Deville's method, by the action of a mixture of nitric and sulphuric acids upon metallic iron. With an apparatus of quite moderate dimensions a dazzling flame, not less than ten inches in height, can be obtained, abundantly sufficient for the purposes of photographic work. It has been estimated that the photographic power of the lamp is superior to that of magnesium, is twice as great as that of the oxyhydrogen light, and three times as great as that of the electric light. Fur-

thermore, the flame is absolutely steady, and there is no danger of its sudden extinction, as with magnesium; and the eye can sustain its brilliance without being affected. Its cost is much less than that of either of the other lights.—1 *D, Dec.*, 1874, 381.

NITRIC OXIDE-BISULPHIDE OF CARBON LAMP FOR PHOTOGRAPHIC USE.

A lamp of the following construction, patented by Sell, in England, is said to afford a light very rich in the highly refrangible rays. Photographs have been taken by means of it, with a comparatively short exposure, which are said to be all that can be desired as to the distribution of light and shade. A small spherical glass vessel, filled with bisulphide of carbon, is supplied with a wick, by which it is fed to an ordinary Wild and Wessel burner, through the centre of which nitric oxide is admitted from a gasometer by means of a tube bent at right angles. This globe is inclosed in a larger one of glass, filled with cold water, to cool the bisulphide. Upon lighting the bisulphide, which can be done without danger, and then regulating the flow of nitric oxide and the height of the wick, a beautiful white light of great intensity may be produced.—14 *C*, CCXV., 1875, 384.

MERRIMAN'S WATER-PROOF LIFE-SAVING DRESS.

The following description is given of this invention, the useful character of which has been so admirably tested by Captain Boynton in his recent trial trips in the English Channel. The dress is composed of two principal parts: the upper portion consists of the shirt or jacket, a head-piece, sleeves and gloves, all in one piece, and made of rubber cloth or other water-proof materials. The lower portion is composed of pantaloons and boots of similar material, and also in one piece. The front of the head-piece, corresponding with the face of the wearer, is made highly elastic, and is provided with an aperture of suitable size to expose the eyes, nose, and mouth. The top, back, and sides of the head-piece are made double, forming a cavity for the purpose of admitting of expansion by inflation. The effect of this inflation is not only to support the head when in the water, but also to draw the elastic edges of the aperture tight about the face, thus

preventing the ingress of water to the interior of the dress. The back and front of the shirt are also double, the cavity in the back extending upward over the back of the neck to the head. The pantaloons are also double from the waist to the knees, forming cavities front and back for inflation. All these cavities are provided with flexible tubes, long enough to reach the mouth of the wearer, and have suitable valves and stop-cocks. By means of these tubes the several parts of the dress may be inflated to any desired degree. At the upper edge of the pantaloons is fastened a rigid hoop, over which is stretched the lower edge of the shirt, and secured water-tight by means of a waist-belt drawn firmly all around. By dividing the dress into two parts, which can be readily united without water-leakage, it can be adjusted by the wearer in a short time and inflated without aid from others. Besides its buoyancy, a special advantage is claimed for the dress from the fact that the air cavities surround the vital portions of the body, and protect it from being chilled by long exposure in the water.

NEW LUMINOUS MIXTURE.

In Paris, the watchmen in all magazines where inflammable or explosive materials are stored are said to use for purposes of illumination a light prepared according to the following method: A clean glass phial of oblong shape is taken and filled with boiling olive-oil to about one third of its volume; into this is dropped a piece of phosphorus about the size of a pea, upon which the phial is tightly closed with a cork. When it is required for use, the cork is removed, the air is allowed to enter, and the phial is recorked. The empty space above the liquid will then be found to have become luminous, the intensity of the luminosity being about equal to that obtained from an ordinary lamp. As soon as the light becomes feeble, it can be restored by opening the phial and permitting the entrance of a fresh supply of air.

PEROXIDE OF HYDROGEN FOR CHANGING BLACK HAIR TO A GOLDEN YELLOW.

Professor Schrötter, of Vienna, examined carefully the high-priced cosmetic recently introduced by Thiellay, of London, for changing the color of black hair to a golden yellow. He

recognized in it simply a dilute peroxide of hydrogen, prepared with well-water, and which owes its permanence to the great degree of dilution and the presence of a small quantity of free acid, most probably nitric acid.—9 *C*, *December*, 1874, 183.

DUST-SPECTACLES FOR THE PROTECTION OF THE EYES IN VARIOUS OCCUPATIONS.

Spectacle frames, furnished with fine wire gauze instead of glass, carefully fitted to the eye, and fastened to the head by a gum band, have been found by Kühn to answer perfectly for the protection of the eyes from dust, solid particles, etc., in various occupations, as threshing, stone-cutting, etc., while they at the same time permit the necessary access of air to the eye, and produce no inconvenience whatever to the wearer.—15 *C*, XVII., 1874, 266.

PRESERVATION OF MEAT, VEGETABLES, ETC., BY ACETATE OF AMMONIA.

According to an English patent, fresh meat, fish, vegetables, etc., are preserved by immersing them in a more or less concentrated solution of acetate of ammonia, and allowing them to dry in the air. If the articles are to be preserved for months or years, they are packed in cans or casks filled with a solution of the salt. The boiling, roasting, etc., readily expels the acetate, and the articles are said to be free from the sweetish taste which acetate of soda imparts.—5 *C*, L., 1874, 400.

PREVENTING THE CURDLING OF MILK BY OIL OF MUSTARD.

The observation of Schalbe, that the addition of a single drop of oil of mustard to 30 grains of milk will prevent its curdling, for weeks, has been fully confirmed by Vogel in exhaustive comparative experiments with fresh milk, with and without oil of mustard, including the determination, from time to time, of the amount of lactic acid present; from which it also appears that this effect of oil of mustard is due to a retarding action upon the formation of lactic acid, its formation being also almost entirely prevented during the first eleven days, and the amount present fourteen days later being only one seventh of that in milk not so treated. Oil

of bitter almonds and oil of cinnamon were found to have a similar effect, but far less in degree; while oil of turpentine, oil of cloves, benzine, carbolic acid, bisulphide of carbon, and sulphureted hydrogen were almost without effect, at least when used in the proportion given for oil of mustard. The additional statement, by Schalbe, that casein was converted into albumen by the addition of oil of mustard, and the suggestion that a cheap method for the manufacture of albumen might be based upon this fact, were not fully sustained by the experiments of Vogel, since the milk thus treated did not always coagulate on boiling.—5 *C*, XLVII., 1874, 375.

CONVENIENT PREPARATION OF CARBONATED WATER.

An ordinary siphon-bottle is employed by Gawalouski, of Prague, instead of the usual Liebig's apparatus, by placing in it, when filled with water, a small tin tube closed with a screw cap, and supplied near the top with several holes about one tenth of an inch wide, and charged, for a two-quart bottle, by placing in it 240 grains of bicarbonate of soda, and upon it a small perforated tin disk, and then 210 grains of tartaric acid. The water passing into the tube causes the development of carbonic acid.—14 *C*, CCXIII., 1874, 402.

CHEAP PREPARATION OF GOOD VINEGAR.

Place an iron-bound oak or beech cask, supplied with a hole half an inch in diameter directly above the spigot, and about one and a half inches below the bung stave, in a cellar that is close and warm in winter, or in some place of similar temperature; first, fill it up to the air-hole with about four gallons of good vinegar (free, however, from purified wood-vinegar, which hinders the formation of vinegar), and allow it to remain for fifteen days, until the wood is thoroughly saturated with it; then draw off from one to one and a half gallons into a second cask, and replace it with as much water, to which a pint of alcohol, free from fusel-oil, has been added. After two or three weeks, again draw off one and a half gallons into the second cask, and replace it in like manner with boiling water and alcohol, and repeat this operation every two weeks. To render the resemblance to wine-vinegar perfect it is only necessary to dissolve some pure tartar in it, and to color it with burnt sugar.—34 *C*, XXI., 1874, 163.

METHOD OF DISTINGUISHING IMPREGNATED EGGS.

A method of distinguishing impregnated eggs from those that are unfertile consists, according to M. Sauvadon, in the use of a tube of pasteboard or of rubber, eight to twelve inches long, and of the diameter of the eggs, through which these are to be examined on the third or fourth day of incubation. They are to be taken, one by one, between the finger and thumb, and held in one end of the tube, which is directed toward the sun, while the eye is applied to the other end. In this way any bad eggs can be easily detected. The good eggs are to be restored to the nest, and at the end of five days, if development is taking place, the fibres of the chicken can easily be perceived through the illuminated shell, and, indeed, the process of development readily followed. This method is, of course, extremely difficult, if not impossible, with eggs that have a colored shell, like those of the pheasant, etc.—3 *B*, *October* 15, 1874, 243.

THE SMOKING AND KEEPING OF SMOKED MEAT.

The following suggestions are among those made by Professor Nessler in regard to the preservation of meat. The keeping qualities of smoked meat do not depend upon the amount of smoking, but upon the uniform and proper drying of the meat. Smoke of high temperature, moisture, and the condensation of water upon the meat are all injurious in smoking meat. With hot, dry smoke the surface is dried too rapidly; a crust, filled with cracks, is formed, and the fat may partially liquefy, and the drying of the interior of the meat be hindered. Bacon is often met with that is brown to the depth of an inch, or even more, simply because it was too warm, or at times moist (sweat), either during the smoking or the subsequent storing. It is doubtless of considerable advantage to roll the meat, on its removal from the salt, before smoking, in sawdust or bran, or to strew it with them, since the crust formed in smoking will not be so thick, and if moisture condenses upon the meat (sweating) it remains in the bran or sawdust, and the brown coloring matter of the smoke does not penetrate the meat. The bran, etc., can easily be removed before using the meat. Warmth, of itself, is not regarded as injurious to smoked meat if moisture

is absent and the air is not too confined. In Greece meat is preserved in the shade of trees, in an airy place, rather than in cellars, although the latter are much cooler, because they are at the same time much damper. If a cellar is not very dry, smoked meat will soon mould in it, even if covered with sawdust, ashes, charcoal, etc. A warm room is also preferable, for the preservation of smoked meat, to such as are liable to great variations in temperature, since in the latter moisture is apt to condense upon it. By far the best place, in most cases, for keeping smoked meat is a suitable smokehouse, in which it remains dry, without drying out entirely, as it does when hung in a chimney.—28 *C, July*, 1874, 67.

NEW METHOD OF PRESERVING MEAT.

A new method for the preservation of meat, by keeping it in a cool, dry chamber, has been communicated to the French Academy by M. Tellier, well known as the inventor of very efficient ice-producing machinery. His new device consists in the employment of methylic ether, a substance that is gaseous at ordinary temperatures and atmospheric pressure, but which can be reduced to a fluid by a pressure of eight atmospheres. The methylic ether is condensed, and then allowed to expand in contact with metal compartments containing a solution of chloride of calcium, which it reduces to a low temperature. Air is blown through this apparatus, its moisture is deposited as hoar-frost on the metal, and it passes in a dry and cold state to the chamber in which the meat is placed. It is found that the flavor of the meat is not injured by retention in this situation for forty to forty-five days, although it is said to acquire a greasy taste after that period.—13 *A, November* 14, 1874, 540.

PRESERVATION OF COOKED MEAT.

Experiments were made by Broxner for the preservation of cooked meat, by cooking 17½ ounces of beef for two hours, by which operation it lost three fifths of its weight, and then squeezing it into a beaker, after cutting it into two pieces, so that it was completely surrounded by a gravy made by browning well 3½ ounces of flour with as much beef-tallow, salting it moderately, and then adding the juice obtained in cooking the meat, mixed with a solution of 60 grains of gelatin in

vinegar. In a few hours the whole mass became firm, and the beaker-glass was loosely covered with paper and placed at the closed window of a low attic room. After ten weeks it was found entirely unchanged in consistency, color, odor, or flavor; and tasted, prepared with the gravy, like freshly cooked meat, although the lowest temperature of the room during the whole period was 45½°, and soiled clothing, fruit, etc., had been kept in the same room. He recommends the process for army use.—28 *C*, *June*, 1874, 468.

PATENT COOLING APPARATUS FOR LIQUIDS.

The following apparatus for cooling water, wine, milk, beer, etc., has been patented in Vienna, and is claimed to be the most efficient and convenient, and at the same time the cheapest. It consists simply of a tube, most conveniently made of tin, with a tight-fitting cover, which is rapidly packed, by aid of a wooden stamper, with pounded ice and salt, either mixed or in alternate layers; this is to be plunged into the liquid that is to be kept cool.—5 *C*, XXXVIII., 1874, 303.

REMOVAL OF DRY PUTTY.

According to an English journal, the difficulty of removing hard putty from a window-sash can be obviated with great readiness by simply applying a piece of heated metal, such as a soldering-iron or other similar implement. When heated (but not red-hot) the iron is to be passed slowly over the putty, thereby rendering the latter so soft that it will part from the wood very readily.—18 *A*, *August* 18, 1874, 601.

PASTEUR'S PROCESS WITH WINE AND BEER.

The supposition that wine treated according to Pasteur's method ceased to be liable to deterioration, even with access of organic spores, because the matter necessary for vegetable growth was separated from the liquid in the operation, was not substantiated by the experiments of Nessler, who found that such wine when exposed to the air exhibited acetous vegetation, in consequence of which vinegar was formed. Absolute exclusion of air is therefore necessary for the complete preservation of wine so treated. Application of the process has also been made, with the most satisfactory results, at

Marseilles, to the preservation of beer in bottles, by heating thirty minutes in a water-bath at 115° to 118½°, and then allowing it to cool rapidly. The taste is rendered somewhat milder by the operation, but with storage this effect ceases to be noticeable. When bottled with carbonic acid, and well corked, it is very effervescent. To preserve it a long time, the temperature should be higher, ranging between 115° and 130°, and it is even well to repeat the heating after several months.—5 *C*, XV., 1874, 115.

GLYCERIN AS AN ILLUMINANT.

Pure glycerin, it is said, may be burned in any lamp so arranged that the wick shall not be elevated above the surface of the liquid, since the sirupy consistence of the material prevents it from ascending an elevated wick. The flame is, like that of alcohol, almost colorless. The ready miscibility, however, of this substance with others has given rise to a number of experiments to determine whether the flame could not be colored with foreign substances. The results of these experiments are said to have been quite satisfactory. By introducing into the glycerin substances rich in carbon, it appears that the flame is rendered suitable for illuminating purposes. It is possible, in view of the cheapness of this material, and its non-volatility save at a high temperature, that this property may find extensive application.

IMPROVED REFRIGERATORS.

An important improvement seems to have been made in reference to the preservation of meat and other food in the inventions of M. Kellier, who demonstrates by actual experiments that methylic ether can be so employed to produce cold as to assure the transportation of viands to very great distances without suffering from the atmospheric temperature. The ordinary refrigerators constructed by his system are said to have preserved meats for two months with perfect freshness. Very suggestive is the construction of a cistern as employed by him for the preservation of viands in every household. This cistern replaces the ordinary movable refrigerator, and is simply a well, the temperature of which is kept very low, and into which the viands to be preserved are lowered by a proper frame suspended from a pul-

ley. The mouth of the cistern is then closed, and the accumulation of water at its bottom is removed by a small force-pump.—13 *B*, III., 180.

NEW MODE OF MAKING BREAD.

Cecil proposes the following process for making bread: After washing the grain well with water, and removing the empty shells, it is hulled by means of a revolving cylinder, with roughened interior, and then soaked for from six to eight hours in a thin, sour paste at 77°; then mashed with rollers, and converted into dough, with the addition of salt and water, which is baked as usual.—14 *C*, CCXVI., 1875, 94.

CLARIFYING AND REMOVING FUSEL-OIL FROM LIQUORS.

Liquors prepared by the following method, patented by Plattner, are said to surpass those of France and Holland in fineness and flavor, as they are altogether free from fusel-oil, and possess a peculiar brilliancy. After the digestion of the ingredients necessary for any particular liquor with potato whisky is finished, the liquid is sweetened with crushed sugar and strained, and one ounce of pure starch, half an ounce of very finely powdered prepared albumen, and half an ounce of milk-sugar are added for every two gallons, and the whole mass is well shaken several times, and then allowed to rest for twenty-four hours, when it will be found beautifully cleared, without filtration. —18 *C*, *May* 5, 1875, 287.

BOHLKEN'S WASHING-MACHINE.

This machine is highly recommended by a German journal, and acts by squeezing rather than rubbing the clothes. It consists essentially of a cylindrical vessel, which is fitted in a frame in such a way that it can be fixed in a vertical or horizontal position at pleasure, and the whole frame can be rotated by means of a crank. The cover can be fitted on it water-tight, with rubber bands and screw clamps, and a heavy zinc cylinder, of nearly the same height but smaller in diameter, is placed within it, but not fastened. The clothes, previously soaped and soaked and boiled, are packed in the vessel in a vertical position, rather loosely, around the zinc cylinder, and it is then filled with boiling soap-suds, and

the cover fastened upon it. It is then turned into a horizontal position and rotated for fifteen minutes, part of the time to the right and part to the left. The zinc cylinder is thus rolled upon the clothes, and operates by pressure, and not by friction.—5 *C*, XIV., 1875, 108.

A NEW SUBSTITUTE FOR COFFEE (SACCA COFFEE).

Lehfeld, of Hamburg, has introduced into the market an article intended to be added to ordinary roasted coffee, prepared from the pulp of the berries and the membranes surrounding the beans. It is claimed that while it is much cheaper than coffee, it imparts a fuller and stronger flavor to the beverage, and exercises a preservative effect upon the aroma and other qualities of the coffee, when ground with it, so that it can be kept without deterioration.—6 *C*, *May* 13, 1875, 188.

IMPROVED DWELLINGS, AND THEIR EFFECT ON HEALTH AND MORALS.

Mr. Charles Gotliff, in a paper read before the Statistical Society of London, states that in 1841 his attention was first turned to the subject of the importance of the improvement of dwellings occupied by the laboring classes. On the fifteenth of September in that year an association was formed for the purpose of providing the laboring men with an increase of the comforts and conveniences of life, with full compensation to the capitalist. During the four subsequent years the stock of this association had been taken up to the extent of $100,000. Other societies were also formed for the same purpose, and at the present time 6838 improved dwellings, capable of containing a population of 32,435 persons, have been erected in London by these agencies. As regards the advantages of these habitations, Mr. Gotliff, from personal knowledge and exact inquiry, finds that in the case of the 1060 families accommodated by the Metropolitan Association of London, the rate of mortality during the past eight years has not exceeded 14 per thousand. This diminished death-rate is shown to be accompanied with a very small proportional number of deaths from zymotic and developmental diseases and from violence. The death-rate is even lower in these improved

houses than in those country districts with which they can be compared. That the low death-rate does not follow from the specially favorable ages of the inmates is shown by the results of the census taken in December last, which shows that in these houses, out of every 1000 inmates, 330 were under and 670 were above ten years of age. On the average, therefore, the inmates were younger than in the population of London generally; since in that city 237 per thousand are under ten years old. If we compare the death-rate of children under ten years old in these model houses with the death-rate of children under ten years old in London generally, we find that it is 24 per thousand in the former, and 48 per thousand in the latter. In fact, the figures show that the population of the model houses is much more healthy than that of the mixed population of London. There is therefore a saving of disease as well as a decrease of deaths; and the advantage conferred upon the inmates, in the shape both of economy of time and the economy of expense, must be very considerable. In these houses the average population is at least four times more to the acre than in the most densely populated parts of London, forming an irresistible argument in favor of the increase and extension of this class of buildings.

But besides this great decrease in the rate of mortality and disease, and the increase in the density of the population, a great check seems to be given to immorality and crime. Indeed, the improved dwellings of the Metropolitan Association, in the facilities they offer for the detection of crime, actually tend to its discouragement and suppression. There are twelve sets of dwellings in different parts of the metropolis, accommodating in all 5300 persons. At each of these points a superintendent and a laborer reside, which officers, in performing their duties, become acquainted with the tenants, their occupations and pursuits, and are instrumental in speedily detecting and removing any bad characters. About twenty years ago, in one of the dwellings of the association, a working distiller established himself with an illicit still. The rent was regularly brought down to the collector, to prevent him seeing inside of the door of the tenanted rooms, and all went on most satisfactorily until the occupant of one of the basements of the dwelling stated his

suspicions to the collector that there was at times a strong smell of mash from the drains. This led to inquiries and an inspection of the premises, when the still was found. The experience of the Metropolitan Association is that the ground-rents of cottages in the country are three and a half pence per family per week, while those of London average eight pence per family per week. Cottages in the country can be constructed at £34 per room, while the construction in London costs £36 per room.

RENEWING WRINKLED SILK.

It is said that silk which has become wrinkled may be made to appear like new by sponging the surface with a weak solution of gum arabic or white glue, and ironing on the wrong side.—18 *A*, *May* 21, 1875, 242.

WASHING WOOLEN CLOTHING.

It has been found on trial that woolen articles treated by the following method, suggested by Dr. Tillmann, do not shrink, and remain unchanged in color. The garments are to be soaked for several hours in a warm, moderately concentrated solution of soda, to which about half a tumbler of ammonia water has been added, more or less, according to the quantity of clothing. They are then to be washed out after the addition of some warm water, and rinsed in fresh water. The same result may be reached by adding a tumbler of ammonia water to a small tub of water, soaking the articles for half an hour in this, and then rinsing them in pure water.—5 *C*, IV., 1875, 32.

AUSTRALIAN METHOD OF OBTAINING COOL WATER.

A simple method of obtaining cool water, practiced very extensively in Australia, seems worthy of introduction into the United States, in localities where ice is not readily procurable. This consists in the use of a large bucket, made of sail-cloth or stout canvas (somewhat like that used for fire buckets), about four feet high and ten inches in diameter. A thick piece of flannel stretched across the top serves as a strainer, and an open cock, a siphon, or some similar arrangement, answers to draw the water. This is to be suspended in the shade, under a tree or elsewhere, where the constant

evaporation, intensified by any passing breeze, brings about a temperature very appreciably lower than that of the surrounding air.—1 *B*, *May* 10, 1875, 93.

METHOD OF PRESERVING EGGS.

Professor Sacc now announces that by far the best method of preserving eggs for an indefinite length of time consists in coating them with paraffin, of which one pound will answer for fifteen hundred eggs. After being thus treated they do not experience any loss in weight, and will remain unchanged for several months. It is essential, however, that the eggs be perfectly fresh, as, should decomposition have commenced, the operation will not prevent its continuance.—1 *B*, *May* 16, 1875, 94.

PREVENTING THE BURSTING OF WATER-PIPES BY FROST.

An ingenious method of preventing water-pipes from being burst by frost has lately been patented in England, and consists in passing through the pipes an India-rubber tube of such diameter that the cavity inside it is little more than equal to the increase in the volume of water by freezing. The result is that when the water freezes it compresses the rubber tube, and thus, having the space required in expansion, all danger of bursting the pipe itself is averted. Of course when the ice melts the rubber expands again. The air is supplied from a reservoir, which is acted upon by the water pressure, so as, automatically, to put the air tube under an exactly corresponding degree of tension. By heating the air in the tube the water in the pipes can be thawed. This application is peculiarly useful in the case of water-closets, and in preventing the supply of cold water to engine boilers from being interrupted by frost.—3 *A*, *May* 2, 1874, 557.

WASHING MUSLIN, CAMBRIC, FRENCH LAWN, ETC.

The articles, after having been well soaked in soft water, are to be rubbed in the direction of the threads (without displacing them) with cakes or balls formed from a mass obtained by boiling and skimming one pound of soap, half an ounce of alum, and one ounce of carbonate of potash. After this they are squeezed out, and the operation is repeated several times.

They are next rinsed repeatedly in clear water (since adhering particles of soap will render them yellow); and are finally rinsed in pure water, to which a few drops of tincture of indigo have been added, after which they are again squeezed out, clapped, and dried in the shade.—34 *C*, XVI., 1874, 128.

BEAUTIFUL ORNAMENT FOR ROOMS.

A very ornamental object may be made of a pine cone, by laying it on a stove until the scales are fully open, then filling the spaces with equal parts of sand and grass seed, and hanging it in a dark room for a week with the lower half immersed in a vessel of water. On exposure to light the seeds will germinate rapidly, and produce a luxuriant growth. When hung up in a window subsequently, it should be watered daily with lukewarm water.—9 *C*, *June*, 1874, 89.

EXTRACT OF MEAT IN BREAD.

According to the Abbé Moigno, the experiment of introducing the extract of meat into bread and into vegetable soups, in the various hospitals and naval establishments of Paris, has proved an entire success, and more than vindicates the claims made for it as a nutrient in cases of sickness.—3 *B*, *April* 2, 1874, 625.

ARTIFICIAL VANILLA.

According to Dr. Hoffman, a crystalline substance growing between the wood and the bark of the fir, named coniferine, when acted upon by oxidizing agents, is converted into vanilline, and is said to be undistinguishable in general character from the vanilla of commerce. It is suggested that if the transformation can be effected cheaply, and the result be as efficient as claimed, the trade in the vanilla bean will measurably cease after a time.—18 *A*, *April* 3, 1874, 64.

YAUPON TEA.

A well-known beverage used by the earlier inhabitants of the United States, and, indeed, by the aborigines of the continent, was that prepared from yaupon leaves (*Ilex cassine*), this forming with the aborigines not only a part of the daily household drink, but, mixed with other substances, being largely employed at religious festivals. A recent analysis

by Smith shows that it contains a great variety of substances, including only a small percentage of théine. In this respect it is about equal to the maté, or Paraguay tea, but far below coffee and tea in its percentage of valuable ingredients.—17 *A*, *September* 1, 1874, 132.

COVER FOR WATER-COOLERS.

A cylindrical cover of wool felt, or similar material, having a wooden top, with a handle attached, the whole covered externally and internally with flannel and coated with varnish or shellac, is made to slip over the vessel to be kept cool. A rubber ring around the open bottom serves to adjust the cover to any inequalities of the vessel.—13 *C*, *February* 15, 1874, 271.

RENDERING FADED MANUSCRIPT LEGIBLE.

According to the *Revue Industrielle* the best method of rendering faded manuscript legible consists in moistening the paper first with water, and then dipping it in a solution of sulphohydrate of ammonia. The ink is said to reappear immediately, becoming very distinct, and remaining permanent on parchment. Certain parchments treated in this way ten years ago still maintain their legibility. This result is due to the fact that, by the action of sulphohydrate of ammonia, the iron which enters into the composition of the ink is transformed into a very black sulphuret.—13 *B*, *July* 31, 1874, 143.

EFFECT OF WASHING UPON VEGETABLES.

The peculiar flavor of all vegetables is affected by washing, but that of the kinds used for salads is especially impaired by water. These should, therefore, never be washed unless necessary, and then only immediately before preparation for the table, and as rapidly as possible, all the water being removed by shaking or whirling in a net or colander.—9 *C*, *September*, 1874, 134.

L. MECHANICS AND ENGINEERING.

PIG-IRON PRODUCTION IN THE UNITED STATES IN 1874.

From the long-expected statement of the Secretary of the American Iron and Steel Association, which has just appeared in the *Bulletin*, we are enabled to give the following official facts and figures concerning the production of pig-iron in the United States for the year 1874. From the statistical information in possession of the Association, the production for 1874 was 2,698,413 net tons, against 2,868,278 net tons in 1873, and 2,854,558 net tons in 1872; showing a decrease of 178,865 tons as compared with 1873, and of 165,145 tons as compared with 1872. Notwithstanding this decrease, however, the production for 1874 is much larger than had been generally anticipated by those best informed.

The accompanying statistical résumé will give a general view of the subject in its bearing upon the past three (3) years:

Years.	No. of Furnaces January 1.	No. of Furnaces built during the year.	Total number of Furnaces December 31.	Out of blast December 31.	In blast December 31.	Production of Pig-iron in net tons.
1872....	*574	41	615	‡115	500	2,854,558
1873....	615	50	665	252	413	2,868,278
1874....	†665	38	701	336	365	2,698,413

The comparatively (and unexpectedly) large production of pig-iron in 1874 the Secretary inclines to attribute partly to the strong hope that was entertained by many manufacturers at the outset of the last year that the depressing effects of the financial panic would soon disappear; and partly to the fact that, of the 413 furnaces that continued to make iron, nearly every one of the large, new, and improved furnaces erected in 1872 and 1873 was included, while those

* Including three spiegeleisen furnaces in New Jersey.

† Two furnaces were abandoned in 1874. ‡ Estimated.

out of blast were furnaces of comparatively small capacity. It was not until near the end of the year that a general determination to blow out was reached, and pending the agitation of this question the few furnaces that were blown out were offset by others (some of them new) that were blown in.

On the 1st of February, 1875, of 701 completed furnaces in the country there were in blast 303 stacks, and out of blast 398. Sixty-two furnaces were blown out in January. Since February 1st the number of furnaces out of blast has been slightly increased. The number of new furnaces completed in 1874 was 38, against 50 in 1873, and 41 in 1872. The Secretary has information that since January 1, 1875, no less than 46 new stacks were in course of construction, while others are projected. The bituminous coal and coke district of Ohio showed the greatest increase of production during 1874, while the Lehigh anthracite district of Pennsylvania is credited with the greatest decrease.

IRON PRODUCTION IN FRANCE.

In 1874 France produced 1,360,000 tons of pig (crude) iron, 760,000 tons of wrought iron, and 155,500 tons of steel. —3 *A, March* 13, 1875, 334.

UTILIZING FURNACE SLAG.

Mr. W. Harold Smith proposes to utilize furnace slag by manufacturing therefrom a cheap and serviceable substitute for bricks and stone for paving and building. In the process invented by him the slag is granulated as it comes from the stack, then mixed with two thirds its weight of cement and subjected to heavy pressure. In this manner he has succeeded in producing smooth, firm, solid blocks that have withstood the severest application of heat and cold.—*Bulletin*, IX., 189.

MANGANIFEROUS IRON.

Iron rich in manganese, or spiegeleisen, has, according to Troost and Hautefeuille, some striking points of difference from common cast iron. For instance, as the latter flows from the furnace it scatters many brilliant sparks, and in cooling disengages, intermittently, bubbles of gas. Spiegeleisen, on the other hand, from the moment it issues out of

the furnace until it is cooled, emits such large quantities of combustible gas as to be covered with a continuous layer of flame. Even after cooling this difference is to be traced in the fact that the manganiferous iron retains a much larger proportion of gaseous constituents than the other, hydrogen of course predominating. Thus a quantity of cast iron yielded 16.7 parts of mixed gases, while the same weight of spiegeleisen gave up 29.5 parts. Carbonized manganese was found by direct experiment to absorb a much greater amount of hydrogen than iron containing the same proportion of carbon.—6 *B*, *April* 5, 909.

STEEL DIRECT FROM THE ORE.

The system *Ponsard*, for producing steel direct from iron ore, has attracted much attention. *La Metallurgie* gives the following account of an experiment made on this system: For several years metallurgists have essayed to treat iron ores in a reverberatory furnace instead of the blast-furnace, which, besides being very costly, can only, as yet, be worked with coke or charcoal, of which the cost has largely increased of late years. All the attempts made in Europe and America have heretofore been unsatisfactory; but the problem has at last been solved. On the 27th of September, at the forge of the Verrières, at Vienne, France, the first production of pig-iron by the direct treatment of the ore in the gas reverberatory furnace, system *Ponsard*, took place under the superintendence of the inventor, with the assistance of M. S. Perissé, director of the General Metallurgical Society of Paris. The apparatus consists principally of a gazogene which transforms the fuel in a series of large chambers, and of a brick appendage, called the recuperator of heat, which receives the flames from the furnace, and restores the caloric in the form of hot air. The compartments of the chamber serve successively for the reduction of the ore, for the reactions which are effected, and, finally, for the fusion of the whole charge in such a manner that the separation of the component parts is effected by the difference of density. These various phases of the operation require very different temperatures, and the production of these is the special object of the apparatus. On the side of the furnace doors the temperature is only that of red heat, while beyond the heat

is so great that the eye is unable to support the intensity of the glow. This extraordinary heat is estimated at 2000° Centigrade.

The success of the experiment is reported to have surpassed all expectations, and the result obtained is considered to demonstrate the possibility of producing steel direct from the ore, without any of the transformations necessary under existing systems. Of course, this is a novelty in the history of metallurgical industry; and it is almost unnecessary to add that, should the system in daily practice justify the report, it will prove a revolution indeed.—3 *A*, *Oct.* 24, 1874.

REVOLVING FURNACE FOR PUDDLING IRON.

A revolving furnace for puddling iron, the invention of Mr. Crampton, has lately been presented to the notice of the Iron and Steel Institute of Great Britain. Small coal or slack is utilized as fuel, and is introduced with a current of air in such a way as to insure perfect combustion, and the consequent absence of smoke. An intense though regular temperature is obtained. A great economy of fuel is claimed for this apparatus, as well as great rapidity of action; since, with a furnace twelve feet in length and six in diameter, the inventor has puddled pig-iron in an hour and a quarter from the time it was cold.—16 *A*, *Oct.*, 1874, 539.

MAGNETIC ORE SEPARATOR.

A magnetic ore separator has lately been invented by Mr. King, in England, for the purpose of separating iron ore from other minerals when associated with them. It is at present employed at the Ballycorkish Mines, on the Isle of Man, where the ore consists of a mixture of galena, blende, and spathose iron ore. The galena can easily be set free, in consequence of its greater specific gravity; but the blende and the spathic ore can not be separated by any ordinary means. A perfectly satisfactory result is obtained, however, by means of the magnetic ore separator. The ore, after being crushed, is roasted at a dull red heat in revolving retorts, when the carbonate of iron is decomposed, and a magnetic oxide produced. The ore is then transferred to the hopper of the magnetic apparatus, which consists of a large drum wheel about eighteen inches in diameter and ten in breadth, fur-

nished within with a system of magnets, arranged radially. The mixed ore, in its passage over a series of four of these drums, has its magnetic portion gradually separated by attraction, and the part that escapes is clean blende.—16 *A*, *Oct.*, 1874, 539.

DISCOVERING THE CHARACTER AND COMPOSITION OF IRON AND STEEL BY ETCHING.

Of late years it has been ascertained that much information can be gathered as to the chemical composition and physical character of iron and steel by etching it, and watching the changes which take place during the operation, and the appearance of the surface after it is completed. According to Professor Kick, of Prague, the best etching substance consists of a mixture of equal parts of hydrochloric acid and water, to which is to be added a trace of chloride of antimony (one drop to the quart of acid). The latter substance seems to render the iron less inclined to rust, so that, after washing thoroughly in warm water and applying a coat of varnish, the etched surface may be preserved quite clean. The smooth surface to be etched is first surrounded with a ridge of wax an inch high, and the water poured into the disk thus formed at a temperature of 55° to 65° Fahr. The action soon begins. The time required for completion is from one to two hours, but the operation should continue until the texture is visible. Every half hour the acid can be poured off without removing the wax, the carbon rinsed off, and the surface examined. When the etching is finished, the wax is removed, the iron washed first with water containing a little alkali, then clean water, brushed, dried, and varnished.—3 *A*, *Oct.* 24, 1874, 523.

NOVEL PHENOMENON DURING THE FORGING OF METALLIC BARS.

At the forging of the bar of iridium-platinum-alloy for the standard meter, M. Tresca states that there were sometimes produced, upon the lateral faces of the piece under the action of the hammer, streaks of light having an oblique direction. When a bar of metal is lengthened by the blow of a hammer on an anvil of the same form as the head of the hammer, which blow produces above and below a sym-

metrical contraction, the effect of the blows is to give to the bar the aspect of a series of projections, separated by small level spaces. At the time of the collision these spaces are connected, at a certain moment, upon the said face of the bar, by luminous lines passing from one to the other, and presenting altogether an appearance of an X written in lines of fire. The phenomenon is only visible at a certain temperature of the bar; and the bands appear simultaneously, but do not disappear together, so that several of these luminous cross-bars are visible at one time. M. Tresca explains this phenomenon as due to the fact that the band which becomes luminous is that along which the plastic metal mainly flows at the moment when the change of form takes place under the hammer. The bright streak, therefore, gives an exact knowledge of the mode of distortion that obtains during the forging. The phenomenon ought to be the same for all metals, except that the relative hardness, capacity for heat, etc., of the metals will determine the brightness, and thence the visibility of the lines.—12 *A*, X., 401.

TUNGSTEN-STEEL.

A simple and, it is claimed, certain process has been perfected by Biermann, of Hanover, by which a white, exceedingly hard and brittle cast iron, containing from five to forty per cent. of tungsten, can be produced, which is adapted to chilled work, and can be added to cast iron in any proportions.—15 *C*, XVII., 1874, 272.

INCREASING THE HARDNESS AND DURABILITY OF SANDSTONE BY IMPREGNATING IT WITH SILICATE OF ALUMINA.

Lewin has obtained most excellent results by impregnating the beautiful, pure, and porous sandstone of the quarries of Neuendorf, at Pirna, with silicate of alumina, employing a solution of sulphate of alumina, and one of silicate of potash. The stone thus treated is preferable to marble for many purposes, and is said to surpass decidedly the artificial stone already much used, especially in hardness and appearance. By polishing, it can also be made to resemble marble, and by subjecting it to a high temperature it receives a kind of glaze, to which any color may be imparted. In the impregnation it can also be colored, according to the use to be

made of it. It is said to resist fire and the atmosphere, and also to be well adapted to water-walls.—8 *C*, *Dec.* 17, 1874, 449.

PRESERVATION OF CLAY PAVING-BRICKS.

According to experiments made in Stuttgart, it was found that bricks that had been coated three times with linseed-oil were less smeary, from wear, in wet weather, as well as more free from dust in summer, than those that had not been so treated. The cheaper petroleum residues were also employed instead of the linseed-oil. Saturation of paving-bricks, sandstone, etc., about manufactories, with hot tar, is also highly recommended where the black color is not objectionable.—5 *C*, XXXII., 255.

INCREASING THE ADHESIVE POWER OF CEMENT.

According to Walters, the force of cohesion in cement may be increased in three ways: by pressure from without; by increase in the volume of single constituents; and by displacement of single constituents, produced by their solubility, taken in connection with attraction and crystallization.

The first of these actions may be greatly facilitated by the workman with his trowel; the absorption of water and carbonic acid from the air produces an increase of volume; and the solubility of some constituents effects their transportation to places where the pressure is comparatively small, and where, on subsequent solidification, they serve to bind the whole more firmly together. The second of these processes is the most important, but unless the proportion between the space left for expansion and the expansion itself be regarded, the mortar will not hold.

According to the author, the chief desideratum of a good mortar is that it shall become impervious to moisture on the outside. This is best fulfilled by Portland cement, which, in increasing in volume, becomes almost entirely indifferent to the action of carbonic acid and moisture.—21 *A*, *July*, 1874, 671.

PRESERVATION OF TIMBER.

Several notices have recently appeared in regard to the merits of the patent process of Rev. Dr. Jones, of Tavistock, England, for rendering timber uninflammable, and prevent-

ing dry rot and decay, and for rendering the softer kinds of timber as hard and durable as oak or teak. The process consists in impregnating the timber with a hot solution of tungstate of soda, the expense being estimated at about six cents per cubic foot, and probably less when a large quantity is treated at one time. It is stated that the trials that have been made are perfectly satisfactory, and that the British government has entered into an agreement with the patentee for the use of the method in the government yards.—2 *A*, *June* 26, 805.

PRESERVATION OF TIMBER BY LIME.

The use of lime for the preservation of wood, especially for railroad purposes, has lately been urged by Lostal, who simply piles the planks in a tank, and places over all a layer of quicklime, which is gradually slaked with water. Timber for mines requires about a week to become thoroughly impregnated, and wood for other purposes more or less time, according to thickness. It is claimed that wood prepared in this way acquires a remarkable consistency and hardness, and will never rot. Beech wood has been prepared in this way for hammers and other tools for iron-works; and it is said to become as hard as oak without losing its elasticity or toughness, and to last much longer than when unprepared. —3 *A*, *April* 24, 523.

PRESERVATION OF WOOD BY MEANS OF IRON.

According to Hubert, iron has always been recognized as the best preservative for wood, and the difficulty in its application does not lie in the impregnation of the wood with it, but in the retention of it in the wood in its most effective form as hydrated sesquioxide, which not only displaces the albumen and other nitrogenous matter, but also renders the wood unfit for the support of insects. Copper, although of great value in this respect, may be dispensed with, and it is not applicable in earth containing ammoniacal matter. It is sufficient, in order to impregnate wood with iron, to drive into it long thin nails with broad, flat heads. These, upon rusting, when the wood is placed in the ground, continually distribute iron through the whole mass of the wood. If preferable, the wood may be wound with iron wire. Wood

has been preserved in this way, in moist earth, for fifteen years; and it is a fact, often noticed, that in old buildings the wood filled with nails has remained sound, while the rest has completely gone to decay.—14 *C*, CCXIII., 1874, 529.

USE OF CARBONIC ACID GAS IN DRYING AND SEASONING TIMBER.

According to a recent patent, moist carbonic acid gas may be used advantageously in drying and seasoning timber. For this purpose the timber to be dried is placed in a properly constructed chamber, and a fire lighted underneath, or hot gases conveyed through the chamber, so as to produce the necessary temperature. With the timber in the chamber is placed a certain amount of water, and the products of combustion, containing of course a large amount of carbonic acid gas, are introduced into the same space. The carbonic acid gas is rendered moist by means of the water, and being heated to a considerable degree, acts directly upon the sap of the green wood, and, in dissolving it, causes it to give out some of its hydrogen, which, combining with the oxygen of the acid, forms water, and then is evaporated, leaving some of the carbon of the carbonic acid in the wood. The removal of some of the hydrogen renders the wood less productive of flame, while the action of the carbonic acid tends to prevent decay in the wood, or to arrest it in the early stage. For this operation the greener the wood the better. It is maintained by the inventor that, if the process is properly conducted, and the wood not too rapidly heated, no piece of wood needs to be split or damaged in drying; that cracks which may have already appeared will not be increased; and that in every respect the quality of the wood is greatly improved, becoming much harder and denser. The cost of fuel in England, for a load of fifty-two cubic feet of scantling, is estimated not to exceed two shillings, and planks three inches thick, of almost any hard wood, dry in six to eight weeks.—18 *A*, *January* 8, 1875, 416.

THE STRENGTH OF WOOD AND THE EFFICIENCY OF THE AXE.

In a recent volume of the annals of the Forest Academy, at Mariabrünn, near Vienna, Professor W. F. Exner gives a novel and highly instructive analysis of the elasticity and

strength of wood, its resistance to splitting, and the theory of the use of the wedge, the axe, etc. The importance of these matters he shows to be very great, because great industries depend upon the facility with which wood can be split, and upon the applicability of certain kinds of wood. Having deduced a few simple formulæ to express the strengths of woods and the power of the wedge, he develops a formula for the force with which an axe is handled, and shows what curve should be given to the face or cheek of the axe in order to secure, under certain conditions, the least waste of power. By means of these formulæ he is able to demonstrate that the splitting efficiencies of the best axes made in Vienna, Prague, and America are to each other as 13.3, 9.2, and 4.9 respectively; and, applying his formulæ to the elaborate experiments of Nördlingen, he is able to deduce the absolute ease with which various woods can be split.—*Annals Mariabrünn Forest*, I., 184.

THE CONSTRUCTION OF WINDING STAIRCASES.

In Major Elliott's Report on European Light-houses he notes that in several cases the stairs are circular, and apparently self-supporting, one end only being built into the wall, as in the Treasury at Washington. This method of stair-building is, he observes, universal in Europe, both in private and public buildings. The most recent light-house towers of the American system are constructed with conical interior walls, and iron staircases winding around the interior of the cone. European towers are generally constructed with an exterior conical and an interior cylindrical wall, leaving an unnecessarily large unused space between the two. The amount of masonry in the American system is the same as in the European, and is better calculated to resist the overturning effect of the severest gales.—*Elliott's European Light-house System*, p. 106.

WALKER'S PATENT ROLLING CARS.

Among other interesting engineering and mechanical novelties, we find reference in *The London Iron* to what is called Walker's Patent Rolling Cars, in which the wheels of an ordinary railroad track are replaced by cylinders, with wheel-heads, and which when combined in pairs, as ordinary car-

wheels, are drawn over the track. As this constitutes practically one rolling body, a comparatively small engine is sufficient to convey the train. The invention has been made, with special reference to the interest of India, for carrying goods, coal, and even water over long distances, through a thinly populated country at the least possible expense. They are protected from the danger of fire and water, and involve a minimum of dead weight.—3 *A*, *September* 26, 1874, 393.

IMPROVEMENTS IN MINERS' SAFETY-LAMPS.

In speaking of sounding and sensitive flames, Mr. A. S. Herschel states that in the application of them to the construction of miners' safety-lamps, which shall make an audible noise on the approach of dangerous gases, we must avoid any vibrations except the extremely small oscillations of a high-pitched note, otherwise elements of danger may be apprehended from the sounding action of the flame. According to Dr. Irvine, the state of musical sensitiveness in Barry's wire gauze sensitive flame is due to the increased inflammability of the burning gas mixture. The gas current, before reaching the wire gauze, will naturally entangle and mix with it a larger quantity of air when it is disturbed than when it issues smoothly. Such a disturbance is produced by the action of external sounds, under whose influence the appearance of the flame is more contracted and boisterous than when the gas jet burns in a surrounding atmosphere of quiescent air.—12 *A*, XI., 1874, 88.

IMPROVED CLOCK-WORK GOVERNOR.

In order to secure perfectly regular motion in the clock-work applied to revolving lights in light-houses, Dr. Hopkinson, the scientific adviser of the glass-works of Messrs. Chance & Co., near Birmingham, states that he has introduced a simple centrifugal governor. The governor balls have to lift a heavy weight, which is in the form of a fly-wheel, the circumference of which, on being raised slightly, presses against certain fixed pads, the friction of which soon diminishes the velocity of rotation of the fly-wheel and the governors, sufficiently to allow these latter to fall back to their original position. He calculates that work to the extent of five hundred pounds per minute must be done on the gov-

ernor in order to accelerate the clock one second per hour. This form of governor possesses the advantage that it checks any acceleration of the clock more promptly than when friction rubbers are carried by the governor balls; and it is also easy to adjust.—12 *A*, X., 460.

INHALATION OF OXYGEN MIXED WITH AIR, BY DIVERS, ETC.

It is stated by Gaudin that, in repeating the experiments of Touzet, by the inhalation of a mixture of equal parts of air and oxygen, he experienced an unusually comfortable sensation, which so far removed the disposition to continue respiration that he could hold his nose and close his mouth without any discomfort for five minutes—a fact which, he suggests, may be of service to divers.—14 *C*, CCXIII., 1874, 531.

NEW SPEAKING AND HEARING TRUMPET FOR DIVERS.

An apparatus, patented by Bremen & Co., of Kiel, and introduced for trial into the German Imperial navy, not only enables the diver to communicate with those at the air-pump, but also to hear distinctly, to a depth of sixteen fathoms, every word spoken at the surface. The absolute safety of the diver being thus secured, it is expected they will be able to work for smaller wages, thus rendering their services available in many cases in which they would otherwise be too costly. It is said that the invention is very simple, and can be attached, without much expense, to any diving apparatus. The main principle involved is the application of vibrating metallic plates for the propagation of the sound, without, however, allowing them to come in contact with the water.—8 *C*, *Nov.* 19, 1874, 415.

APPARATUS FOR RECORDING SIGNALS AUTOMATICALLY.

Mr. W. Smith gave an account before the British Association of an apparatus devised by him for recording signals automatically, on a paper, in connection with the movement of railway trains, so as to show exactly the circumstances under which the movements of the train had been directed and executed. The apparatus itself records: 1. The direction given and received for regulating the movements of trains. 2. The movement of every signal of every kind or description. 3. The movements of the points and other por-

tions of the road and way affecting the movements of trains or engines. 4. The passing of trains in every direction; and, 5. The time and relation to such movements, etc., all in a succinct form, upon the same roll or strip of paper. These results are obtained by connecting with the reciprocating parts of the points and signal-working, or with the interlocking gear, a peculiar arrangement of electric contact making and breaking apparatus, acting through a simple electro-magnetic contrivance, which, in turn, operates on and deflects a pen or style, which records upon the strip of paper the movements in question.—15 *A*, *Sept.* 5, 1874, 323.

HISTORY OF DUPLEX TELEGRAPHY.

In an investigation into the mathematical theory of the workings of duplex telegraphy, the author, Mr. Schwendler, electrical engineer of the Indian government, gives a short sketch of the history of duplex telegraphy, in which he states that as early as 1849 Messrs. Siemens & Halske, of Berlin, took out a patent in England for the simultaneous transmission of a plurality of messages. In 1854 Dr. Gintl, of Vienna, effected the practical solution of the same problem by employing an electro-chemical method, and in the following summer a differential method was independently arrived at by Siemens & Halske, of Berlin, and by Frischen in 1855. In Sweden Edlund employed a differential method, which he had invented in 1848. The theory of Zantedeschi—namely, that of distinguishing electric currents passing simultaneously from opposite directions through the same conductor, without in any way interfering with each other, and on which that physicist has claimed the honor of having first suggested the idea of duplex telegraphy—is characterized by Schwendler as being in direct opposition to the electrical laws which were already known in 1829. None of the above methods had any extended application; they appear to have been attempted doubtingly, and were generally rejected as impracticable. Only recently, after a torpid existence of almost twenty years, has duplex telegraphy secured the amount of public interest it rightly deserves; and to Mr. Stearns, of New York City, is due the credit of having appreciated its value, and by means of his own inventions proved its thorough practicability. The invention of the

duplex method ranks second in importance only to Steinheil's discovery in 1837 of the feasibility of employing the earth to complete the electric circuit, instead of a return wire. Of the causes that have thus delayed the introduction of so important a system, perhaps the most striking was the fact that the invention was twenty years ago in advance of the age; and again that the telegraphic profession, young as it is, is far more conservative than is good for the advance of telegraphy.—7 *A*, XLVIII., 122.

BALLOON VOYAGE FROM BUFFALO TO NEW JERSEY.

A very interesting and in some respects remarkable balloon ascension was made on the night of the 4th and morning of the 5th of July, 1874, by the well-known aeronaut S. A. King, of Boston. The ascent was made at Buffalo about six o'clock Saturday evening. The course of the balloon was at first slightly east of south, and gradually changed more to the eastward, until a landing was effected at Salem, New Jersey, about seven o'clock Sunday morning, the entire distance traveled in thirteen hours being, in a direct line, nearly 350 miles. The latter part of the journey lay in the path of the terrible tornado which swept over Eastern Pennsylvania and New Jersey on the afternoon of the 4th of July, and which caused great destruction of crops, etc. The balloon employed in this trip is, with two exceptions, the largest ever built in this country, having a capacity of 91,000 cubic feet. The greatest height attained above the earth's surface was 9750 feet, at which elevation the temperature was 68°, it being then a quarter before seven in the morning. Coggia's comet was watched with much interest, and was seen with great distinctness through the early half of the night.—*Boston Journal, July* 10, 1874.

DISASTROUS TRIP OF THE BALLOON "ZENITH."

The disastrous termination to a balloon ascent lately undertaken in France, in the interest of science, has attracted much attention in Europe; this occurring in the case of the balloon *Zenith*, on the 15th of April, 1875. On that date M. Gaston Tissandier and M. Crocé-Spinelli took passage in the *Zenith*, which was in charge of M. Sivel, the special object of the ascent being the determination of the quantity of

carbonic acid gas contained in the atmosphere at an altitude of 24,000 feet. The experiment of the inhalation of oxygen, after attaining a considerable altitude, was tried, to ascertain its effects; but at a height above 22,000 feet M. Tissandier fainted. He was shortly afterward awakened by M. Crocé-Spinelli, who warned him to throw over some ballast, which was done. He then fell asleep for about an hour, and on awakening found the balloon descending at a terrific rate. No more ballast was to be thrown away, and his two friends were suffocated. Their faces had turned black, and the blood was flowing from their mouths and noses. M. Tissandier's only resource was to cut the grapnel rope a little before the instant when the car should strike the ground, and the balloon was torn open to stop it. It was finally caught on a hedge about 190 miles southwest of Paris.

The temperature of minus 10° Centigrade was observed at the height of 22,960 feet, but it was supposed the altitude to which the balloon had ascended was considerably greater, the indication of the self-registering barometer being 14,000 meters, or eight miles.—12 *A*, *April* 24, 1875, 495.

CASING FOR STEAM-PIPES, ETC.

The following composition for casing steam-pipes, etc., is recommended by a German association of engineers as equal in effect to that of Leroy, while it is cheaper: Mix well 120 parts, by weight, of finely ground limestone, 350 of finely ground stone-coal, 250 of finely ground clay, 300 of flue-dust (from the boiler flues), 600 of water, 10 of sulphuric acid of 50° Baumé, and 15 of hair. The place to be covered, warmed if possible, is coated with this mass in layers, from half an inch to 1½ or 2 inches thick, and when finished may be painted.—14 *C*, CCXIII., 1874, 169.

CONSUMPTION OF WOOD BY RAILWAYS.

The National Car Builder reports that at the close of 1873 there were 71,564.9 miles of main lines, and 13,512 miles of sidings and double tracks, making 85,076.9 miles of railway within the United States. Upon these roads the larger proportion of the locomotives consumed wood for their fuel. The number of ties used varies from 2200 to 2800 per mile. Taking 2500 as the mean, it appears that 212,692,500 pieces

of timber, eight feet long and from six to eight inches between the upper and lower surfaces, are required to supply this single item. The durability of ties varies, with climate, kind of timber, soil, and usage, from four to ten years. Assuming six years as the average life of a tie, the amount required for annual supply must be 35,488,750 pieces, or 94,530,000 cubic feet. In considering this item it must be remembered that a large amount of waste occurs from hewing and other causes. It must also be borne in mind that the demand for timber by railroads, besides that used for ties and fuel, is enormous, including fencing, bridges, buildings, and other structures in great variety and number; that the risk from fires is exceptionally great, and that our requirements in this direction are increasing even more rapidly than our supplies are wasting away.

GOLD-MINING IN THE PHILIPPINE ISLANDS.

According to a letter from Minard to Daubrée, the working of the auriferous quartz in the Philippines has been abandoned, the alluvial deposits having proved much richer in grains and scales of gold. It is associated with fragments of dioritic rocks, as itaberite, with magnetite and titanic iron, the gold occurring in tolerably large grains, while quartz is seldom present. Native platinum is also found with it, and, in the samples sent, small zircons with quadrangular pyramids on each end were recognized, as they usually occur in auriferous alluvium.—3 *C*, *July* 27, 1874, 600.

NEW CARBONIC ENGINE.

De Beins, of Amsterdam, has communicated the results of his latest experiments with carbonic acid motive-engines. He has for many years studied the question of the transformation of heat into mechanical power, and in seeking to ascertain the degree of pressure evolved by carbonic acid disengaged from bicarbonate of soda heated in a confined space he found that when the bicarbonate of soda, or of potash, either in the condition of dry powder or of an aqueous solution, was heated in a confined space, a part of the carbonic acid became disengaged, and condensed in a cool part of that space, in such a manner that at the temperature of 250°

to 400° C. liquid carbonic acid could be distilled from these salts under a pressure of 50 to 60 atmospheres.

This fact he considers of great importance, as carbonic acid under high pressure (or, as Beins calls it, "Carboleum") is physically a very remarkable body, which may be easily obtained in large quantities. The study of the relations of bodies submitted to high pressure is only in its infancy, and to pursue it a simple apparatus for compression is all-important. For pressures of less than 50 or 60 atmospheres it is of course not necessary to raise the temperature to 300° and 400° C. With a saturated solution of bicarbonate of soda, heated to boiling point in a bath of concentrated common salt, carbonic acid of three to five atmospheres is obtained, and the pressure increases regularly with the temperature.

Carbonic acid at a high pressure, or carboleum, supplies excellent motive power for small and great industries. This was remarked by Faraday, who discovered liquid carbonic acid, and, since, by Thilorier and others; but unfortunately the law of the preservation of the energy, indispensable in such cases, was not known. A liter of carboleum at 15° C., and with a pressure of 50 atmospheres, weighs approximately 0.8 kilos., and will produce 400 liters of carbonic acid at the ordinary pressure. The power required to produce compression to the extent of 50 atmospheres is equal to about 17,000 kilogrammeters. This gives 270,000 kilogrammeters per hour, and per horse-power, for 16 liters of carboleum at 50 atmospheres, and 15° C.

It is only when a carboleum engine works with large intervals between that the heat of evaporation can be carried to the sides without heating artificially. In the majority of cases the carboleum must be evaporated by the artificial heating of small quantities at a time. The heat required per horse-power per hour, as already given, namely, 270,000 kilogrammeters, is equal at least to 640 calorics (0.1 kil. of coal).

Large carboleum engines should be worked with regeneration. They should have a dépôt of salt of soda and carboleum, so arranged that the decomposed bicarbonate shall be regenerated by the carbonic acid which has worked the engine. Such a machine transforms very advantageously into

mechanical power the heat supplied by the fire to decompose the bicarbonate constantly regenerated. Supposing the gas to act at the temperature of 100° C., the 16 liters of carboleum necessary per horse-power per hour will be reduced to 10 liters. Such an engine requires about 0.3 kilos. of coal per horse-power per hour, while the best constructed steam-engine consumes 1.2 to 0.9 kilos. For ships, the weight of an engine of 100 horse-power, with fuel for 240 hours, will be one fifth less than that of a steam-engine of equal power. And as several parts of a carboleum engine require to be more massive, it will take up less room. Carboleum presents no danger, as it contains no cause of explosion. It is easy to prevent a too abundant accumulation of gas in the engine-room, which would render the air unfit for respiration. When not in contact with water the metallic parts of the engine are not affected by the carbonic acid. Metals are not permeable by gases at that pressure. In large works the carboleum engine will, it is claimed, in nearly all cases, replace the steam-engine. In small establishments, and especially where the engines are only worked at intervals and for short periods, the fact of the carboleum being always ready to act at a moment's notice is of great importance; as, for instance, to drive printing-presses, steam pumps, portable engines, etc. A carboleum engine is an excellent and economic source of electric light. M. Beins also recommends the carboleum engines as especially adapted to submarine vessels.—3 *A*, *October* 24, 1874.

REPORT ON THE RECLAMATION OF THE ALLUVIAL BASIN OF THE MISSISSIPPI RIVER.

The report of the commission of engineers appointed to investigate and report a permanent plan for the reclamation of the alluvial basin of the Mississippi River subject to inundation has lately been published. This commission, of which General G. K. Warren, of the United States Engineers, was chairman, was appointed under an act of Congress in June, 1874, and held its meetings first at Newport and then at Washington, its members visiting from time to time the localities in the Mississippi Basin requiring particular investigation.

At an early stage in the deliberations it was decided that, although the judicious use of artificial reservoirs in moderating the destructive effects of rivers had its advantages, yet —first, this method of protection against overflow was inapplicable to the lowlands of the Mississippi; second, that no reduction in the height of the floods of the Mississippi can be obtained by diverting any of its tributaries from their present channels; third, that the local benefit above their sites which results from cut-offs is more than counterbalanced by the injury sure to result below in an increased flood-level and caving of the banks; fourth, that outlets of limited capacity, merely sufficient to reduce the flood-level a few feet, would be advantageous, provided a free channel to the Gulf could be found for water so abstracted from the river; fifth, that the expedient of withdrawing water from one part of the river to be subsequently returned below is sufficiently dangerous to be adopted unwillingly, and only as a choice of evils; sixth, that as all cultivation of the Mississippi bottom-lands owes its success to the construction of levees, the committee has confidence that the system properly applied is adequate to the protection of the country against floods. Whether it should be exclusively trusted, or be combined with outlets, is a matter to be decided by economical considerations.

The committee also decided that all openings for overflows previously existing should be maintained, and that one of these outlets (the Bayou Plaquemine) having been closed, it should be reopened, provided it can be done without danger of a disastrous enlargement.

A general levee system extending from the head of the alluvial basin to the Gulf, which shall likewise include valleys of the tributary streams, should also be established. They estimate the total area of the bottom-lands to be about 32,000 square miles, of which but a trifling strip has heretofore been available for agricultural purposes. Should the recommendations of the commission be carried into practice, it is estimated that it would reclaim and make available not less than 2,500,000 acres of sugar land, 7,000,000 acres of unsurpassable cotton land, and 1,000,000 acres of corn land of the best quality. The estimates of cost, etc., which are given as simply approximations, speak of 115,000,000 cubic

yards of levee at forty cents per yard, reaching a total of $46,000,000.

JESTY'S ANTI-FOULING COMPOSITION.

The copper sheathing of two royal English yachts was covered in the fall of the year, by order of the Admiralty, with Jesty's Anti-Fouling Composition, and, after remaining moored in the harbor until the end of the following April, they were found as free from algæ and other deposits as when first coated, except in very small patches near the rudder.—14 *C*, CCXIII., 1874, 257.

HYDRAULICS IN THE ADIRONDACK PLATEAU.

At a recent session of the New York Legislature a survey of the Adirondack plateau was authorized, to determine the probable cost of accumulating a reserve of the surplus waters of that region for the use of the Hudson and other streams. This was placed in charge of Professor T. N. Benedict, of New Jersey (formerly of Burlington, Vt.), who has spent much time in the study of the physical and topographical character of the region. The instrumental work was performed by two parties, one under Professor Benedict, and the other under Mr. W. B. Cooper. Professor Benedict took charge of the lakes and ponds of the upper sources of the Hudson, including a part of the Racquette River, while to Mr. Cooper's party was assigned the triangulation of Long and Forked Lakes, and the examination of the Racquette Valley below Long Lake. The gauging of the main channel of the Hudson, above the junction of the Mohawk, was accomplished in October by Professor Benedict.

As the result of these inquiries Professor Benedict reports: first, that immense quantities of water can be safely stored at a comparatively low percentage of cost on the upper Hudson, most of which is now worse than lost, as it runs to waste in spring freshets, which in various ways are the cause of much damage; second, that this excess is sufficient to maintain the deficiency of the main river, at low summer stages, for 100 days, after liberal discount for losses on its passage. The lakes of the Racquette basin, alone, are alleged to have a capacity more than six times that of the Black River reservoirs, which supply the eastern division of the Erie Canal.

HEAT AND PRODUCTS OF GUNPOWDER EXPLOSIONS.

According to recent experiments by Captain Noble and Mr. Abel, the temperature of the explosion of gunpowder, by means of platinum wire or tin-foil, is about 2200° C. The products of explosion consist of about fifty-seven parts, by weight, of solids, to forty-three of permanent gas. When the powder fills the space in which it is fired, the pressure is about 6400 atmospheres, or 42 tons to the square inch. The products of explosion generally are the same in a gun and in a completely closed vessel, while the work on the projectile is due to the elastic pressure of the permanent gases.—3 *A*, *Nov.* 21, 1874, 66.

EXPLOSIVE AGENTS.

The report of Professor Abel on explosive agents as applied to industrial purposes, delivered to the Institution of Civil Engineers, and the discussions thereon during the past three years, have been recently published in a pamphlet, from which the following facts are taken.

Passing from the consideration of gunpowder to those substances that have been proposed as substitutes therefor, Professor Abel considers the three principal ones as picric acid, nitro-glycerine, and gun-cotton.

Nitro-glycerine has been raised from the position which it held for sixteen years, as a rare and apparently useless chemical, to that of a most important industrial agent, through the skill and perseverance of Mr. Noble, who, in 1863, made public his proposition to add to the explosive power of gunpowder by impregnating the grains with nitro-glycerine. In 1864 Mr. Noble described several methods of exploding charges of nitro-glycerine, and showed that the explosion takes place with such great rapidity that it is unnecessary to confine the charge by tamping or any other means. Nitro-glycerine is now extensively employed, not only in California, but in Sweden, Germany, and Wales. The poisonous nature of the exploding gases, which injuriously affects the health of those handling it, is one of its defects. The material is much less susceptible to accidental detonation in the frozen than in the liquid condition. The accidents which have occurred with frozen nitro-glycerine appear to have

arisen from a reckless use of the material. The endeavors of Mr. Noble to diminish the chances of the accidental explosion of the liquid substance led to the production by him, in 1867, of the solid preparation of nitro-glycerine, known under the name of dynamite, which constitutes, as now manufactured, one of the safest, most powerful, and most convenient explosive agents. Dynamite, as originally prepared, consisted of about 75 per cent. of nitro-glycerine absorbed by about 25 per cent. of a porous, infusorial, silicious earth found in Germany. This substance is now furnished to the trade in cartridges whose charges have the consistency of dry putty. During the late siege of Paris attempts were made in that city to substitute some other earth for that used in Germany. The most efficient absorbents were found to be silica, tripoli, alumina, and sugar. None of these, however, is considered to be so efficient as the German mineral. The preparation called glypto-fractur is stated to be a secret composition, but it has been publicly acknowledged by the manufacturers that the material is a modified dynamite, for which, however, special merits in regard to safety and power are claimed. It is difficult, however, to conceive that it can be more powerful than the original pure dynamite, from which it differs principally in containing a larger percentage of earths. Professor Abel believes that Noble's dynamite has a decided superiority over glypto-fractur in respect to the retention of nitro-glycerine at different temperatures. Exploding nitro-glycerine in its pure or liquid form is pre-eminently dangerous, and therefore only likely to receive exceptional application.

Professor Abel makes a comparison between the destructive effects of dynamite and compressed gun-cotton, and states that, generally, in all operations where rapid destruction is to be accomplished, gunpowder is undoubtedly inferior to these new explosive agents. Not only would a much larger quantity of powder be required to produce similar results, but in some cases it would be impossible to perform the same operations. In tunneling in the slate quarries of North Wales, a work that costs 60 shillings per cubic yard for gunpowder is done in less time for 45 shillings per yard with compressed gun-cotton. In experiments made by Mr. Hawkshaw, it was found that a detonation of gun-cotton

charges, placed simply upon the surface of submerged soft chalk rock, would break up the latter so as to facilitate its rapid removal by dredging, the rock being completely disintegrated, or pounded into a plastic mass like clay. Comparing the effects of dynamite containing 75 per cent. of nitro-glycerine with those of gun-cotton, the two materials appear to be practically on an equality, weight for weight, but the results furnished by either of them are accepted as being about six times those produced by gunpowder. The most prominent advantage of dynamite over gun-cotton is that it may be used in a damp hole without fear of its missing fire; while, on the other hand, compressed gun-cotton possesses the advantage that it is not in any way injurious to handle, is not at all affected in its explosiveness by cold, and may be preserved for any length of time without deterioration in its damp and unignitable state. The vapors evolved from the explosion of either of these are decidedly more objectionable than gunpowder smoke.—*Abel on Explosive Agents.*

AN INGENIOUS AND NEW MOTOR.

According to the laws of the mechanical theory of heat, mechanical work can be produced by the employment of any differences whatever of heat; and a very simple device has been invented by Bernardi, which is curious, if not of industrial value. Two glass globes are united by thin metallic arms to a central drum, the arms being bent at right angles when they enter the globes. The globes are partly filled with ether. An axle passes through the central drum in such a way that as it revolves, carrying the arm and the globes with it, the globes successively dip into a basin of cold water. Each globe is covered by a very fine network, which, becoming wet in that part of its revolution that carries it below, is subsequently, during the greater part of its revolution, exposed to the air. Evaporation of the water over the exterior of the network, and the consequent cooling of the globe, causes a slight condensation of ether in its interior, more of which is supplied from the opposite globe then being immersed in water, the upper or exposed globe becomes the heavier, and by its tendency to sink keeps the axle in continued but slow rotation, which does not cease so long as

water is supplied to wet the globes. A number of such pairs of globes being fastened to the axle, sufficient force is produced to turn a delicate clock-work. An apparatus constructed by Bernardi, with globes having a diameter of three fourths of an inch, and with arms three inches long, has worked for three months without change; in which period he calculates that the quantity of heat consumed by the apparatus has been equivalent to sixty revolutions of the wheel per day.—13 *B*, III., 80.

THE PYROLETER.

A new apparatus for the preservation of life and property from fire at sea, called the Pyroleter, or fire destroyer, was lately tested in England. A barge of some 40 to 50 tons' burden was fitted up for the purpose of the experiment. Along the entire length and width of the hold cotton-waste, shavings, and small wood saturated with oil and naphtha was placed to about the depth of two feet, and ignited on a given signal, within two minutes of which time dense volumes of flame and smoke issued from the open hatchways. The hatchways were then battened down, and the apparatus being set to work, the flames were completely extinguished within four minutes. The Pyroleter, by means of which this result was effected, is a small pump, which draws from tubs placed on each side of it simultaneous supplies of diluted hydrochloric acid and a solution of sodium bicarbonate. Both mixtures then meet in a generator and instantaneously pass into a separator, whence dry carbonic acid gas is evolved, and passes through fixed pipes to the *locale* of the fire, which it speedily suppresses. The chief merit of the invention is that a fire can be readily extinguished by dry gas with the assurance of no damage to the cargo therefrom.

ETCHING IRON.

Much time and attention has been devoted by Professor Kick, of Prague, to the subject of etching iron with acids. His method for arriving at a knowledge of the quality of iron or steel is not a new one, having been used with some success for a long time, but the care with which the Professor has conducted his experiments makes them exceedingly valuable.

Some kinds of iron exhibit what is known as the passive state, and are unacted upon by acids until this state has been destroyed by heating. The surfaces thus prepared are inclined to rust very soon. After a series of experiments with nitric, sulphuric, and hydrochloric acids, and etching solutions of copper salts, Professor Kick found that a mixture of equal parts of hydrochloric acid and water, to which was added a trace of chloride of antimony was the best etching solution. The chloride of antimony seems to render the iron less inclined to rust, so that after washing thoroughly in warm water, and applying a coat of Damar varnish, the etched surface may be preserved quite clean. The smooth surface that is to be etched is surrounded by a ridge of wax an inch high, as is done in etching copper for plates, and the acid is poured into the disk thus formed. At a temperature of 55° to 65° Fahr. the action soon begins, as shown by the gas evolved; in winter the etching is poor. The time required is from one to two hours, but the etching should go on until the texture is visible. Every half-hour the acid can be poured off without renewing the wax, the carbon rinsed off, and the surface examined. If too much chloride of antimony is added to the acid, a black precipitate will soon form, which can easily be distinguished from the carbon. One drop of chloride of antimony to the quart of acid is sufficient. When the etching is finished the wax rim is removed, the iron washed first in water containing a little alkali, then in clean water, brushed, dried, and varnished. If in a few hours it begins to rust, the varnish should be removed with turpentine, which will also take off the rust, and then varnish again.

The appearance of different kinds of iron, when etched, is essentially as follows: Soft or sinewy wrought iron of excellent quality is attacked so equally by the acid, and so little acid is separated, even after several hours' action, that the surface remains bright and smooth. Fine-grained iron acts the same; the surface is still smoother, but a little darker. Coarse-grained and cold-short iron is attacked much more violently by acid than that just mentioned. In ten minutes, especially with cold-short iron, the surface is black. After thirty minutes a black glass can be washed off, and the surface will remain black in spite of repeated washings, and exhibits

numerous little moles. Certain parts of the iron are usually eaten deeper, while others, although black and porous, offer more resistance. By allowing the acid to act for an hour or so, then washing, drying, and polishing with a file, a distinct picture is obtained. Malleable cast iron, we know, rusts more easily than wrought iron, and it is an interesting fact that the action of acids is also violent, the surface being attacked very intensely. Gray pig-iron acts like steel; the etched surfaces have quite a uniform gray color. In puddled steel the color of the etching and washing is gray, with a uniform shade, and the lines are scarcely visible. Cement steel has a very similar appearance, the lines being very weak. In Bessemer and cast steel the surfaces etched are of a perfectly uniform gray color, with few, if any, uneven places. The softer the steel the lighter the color. On etching, the finest hair-like fractures are rendered prominent. A piece of steel, which looked perfect before etching, afterward exhibited a hair-like fracture throughout its whole length. When different kinds of iron are mixed, the acid attacks that for which it has the greater affinity, while the other is less acted upon than if it were alone. Etching is exceedingly valuable to all who deal largely in iron, as it enables them to determine with comparative accuracy the method of preparing the iron, as in the case of rails, etc., as well as the kinds employed. —3 *A*, *October* 4, 1874, 523.

SCHMITZ'S REVOLVING FURNACE-BARS.

The *London Iron* speaks with much approbation of Schmitz's Revolving Furnace-bars, in which the ordinary straight fire bars are replaced, singly or in pairs, by hollow cylindrical bars, pierced with holes, and so arranged as to be easily capable of revolution. These bars rest on supports which are themselves cylindrical and hollow, and are supported lengthwise by a plate beneath the door of the fire-box, and fitting into a neck made at the near end of the bar. For revolving them a winch is inserted in the hexagonal opening in the front end of the bars, by which they are turned.

The lighting of the furnace is performed in the ordinary way, and the furnace door can be kept completely closed, the perforations of the hollow bars supplying as much air as

is necessary, and to a much greater advantage, as it passes directly through the coal instead of playing on the top; and the combustion is much more uniform and thorough. At intervals the bar is turned partly round, and a clear surface free from slag and scale is presented to the fuel. The ashes which fall through the perforations of the grate can be pushed out into the ash-pit, thus avoiding the necessity of raking down.

Another advantage claimed for this grate is that a larger charge of coal can be put into the furnace than usual, thus avoiding the necessity of a frequent opening of the front. In an experiment by the Paris Gas Company with these bars, the fuel used was an agglomerated coke dust—which could not be used in ordinary furnaces—and which resulted in complete success, and by which it was claimed that a saving of 26 per cent. was made.—3 *A*, *April* 24, 520.

CORK AS A NON-CONDUCTOR OF HEAT.

Experiments conducted at several important works in France, during a number of months, are declared to have established the fact that cork is entitled to the first rank as a non-conducting substance well adapted for the purposes of practice. In the account from which our information is derived, it is said that after eighteen months of service upon the steam-pipes of sundry establishments, the cork remained intact, and had suffered no practical deterioration of quality. Although the durability of this substance had been proved before by the buoys which are subjected to the severe test of a partial immersion in water and exposure to weather, its ability to withstand such high temperatures as those of steam-heated surfaces required experimental demonstration. This point, according to our authority, has been satisfactorily settled. In addition to its durability, its lightness, the readiness with which it yields so as to surround the cylinders or pipes, the facility with which it can be taken down and put in place again whenever inspection or repairs of boilers and pipes require it, and above all its eminent non-conducting powers, entitle it to the first rank as a heat-saving lining to steam-pipes and for related applications. The engineers of the French Navy, after a lengthy examination of its merits, have, according to accounts, given it their formal approval in

a report to the French Admiralty. In view of the deficiencies of most of the materials hitherto employed by steam users for the above purpose, the claims of cork to such eminent practical utility may be worth an examination.—*La Metallurgie.*

THE NEW MONSTER CANNON OF ENGLAND.

When the English had cast their cannon, the "Woolwich Infant," of 35 tons, it was supposed that the limit attainable by engineers had been reached, and would not soon be surpassed. But the success of the first infant seems to have been only an incentive, and now the world is astonished by the appearance of a new monstrous cannon of 81 tons, destined to form a part of the armament of the iron-clad *Inflexible.* It is well understood, even by those not professional engineers, that the perfection of metallurgical processes has enabled the art of defense to keep pace with that of attack. The old cannon of 25 tons, and its projectile of 700 pounds, were no sooner eclipsed by the production of heavier iron-clads, than the cannon of 35 tons was made in order to overcome the new resistance. No sooner was the latter ordnance finished than the Russians constructed an iron defense of 20 inches' thickness, on which the 35-ton cannon had no effect, as shown by the experiments at Shoeburyness and Woolwich. It became then urgent to construct a new type of cannon more powerful than its predecessors, which should be able to cope with the defenses of the Russian monitors. An 81-ton monster is accordingly now nearly finished. It is constructed according to the method of Frazer, which differs from that of Armstrong in that the fibres of the hoops around the breech which inclose the steel tube, instead of being placed lengthwise of the cannon, are disposed transversely to its axis, which gives the metal greater resistance to the shock of explosion. The whole is formed of seven pieces: five hoops of forged iron, one tube of steel, and the solid breech end. Its total length is 27 feet; its calibre, when finished, will be 16 inches, but the first series of trials will be made with a calibre of 15 inches, after which the gun will be still further bored out. Its trial will take place in July at Shoeburyness, the charge being over 300 pounds of powder, and the weight of the

projectile over 1700 pounds. Its range under these conditions is estimated to be about six miles, and the force of the projectile is such that it will pierce a plate of iron 25 inches thick at a distance of one mile. The entire equipment of the *Inflexible* comprises four pieces of ordnance of this same size.—13 *B*, III., 100.

CEMENT FOR MARBLE AND ALABASTER.

We find in the *Bulletin* of the Chemical Society of Paris the following formula for a cement for marble and alabaster: 12 parts of Portland cement, 6 parts slaked lime, 6 parts fine sand, and 1 part of infusorial earth are made into a thick paste with silicate of soda or soluble glass. The object to be cemented does not require to be heated. It sets in twenty-four hours, and the fracture can not be readily found.—1 *A*, *April* 23, 185.

PREVENTING INCRUSTATION IN STEAM-BOILERS.

Among the many devices for preventing incrustation in steam-boilers, that of lining them with thin copper plates is said to be very effective. In certain cases, where the boiler had strips of copper placed inside of it, other portions not being covered, after a certain time it was found that the uncoated portions were incrusted five and six times as much as the copper-lined, the copper remaining also uncorroded. It is claimed that in addition to the diminished amount of incrustation and the less corrosion of the copper, the vaporization is more complete, and that there is a corresponding saving of fuel.

In the construction of a boiler to be lined with copper, it is stated, and not without reason, that the weight of the boiler is considerably reduced, since the iron plates may be of less thickness, and the expense thereby diminished. It is remarked, however, that the question still remains as to the galvanic effect of the contact of the two metals, and the action of waters less calcareous but more acid than that with which the experiments referred to were prosecuted.—3 *A*, *June* 5, 715.

COPPER LINING FOR STEAM-BOILERS.

The editor of the *Engineering and Mining Journal*, in referring to the above suggestion of using a lining of copper

for the protection of boilers from incrustation, remarks that such a combination has been found very injurious, on account of the galvanic action of the two metals, and that more satisfactory experiments are required, with waters of different qualities, particularly with the acid water common in coal-mines, before much reliance can be placed upon the so-called improvement.—*Engineering and Mining Journal, June* 26, 478.

ELECTRIC FUSES.

A series of memoirs and discussions on the subject of electric fuses and the efficiency of torpedoes, submarine blasting operations, etc., has occupied the attention of the Society of Telegraphic Engineers; and among the papers presented, especial interest attaches to that of Professor Abel, on account of his extensive experience in these matters. He holds the opinion that the many disappointments and accidents that have occurred in connection with electric fuses are, in general, not to be attributed to the electricity nor to the fuses, but rather to the carelessness of the operators. It can always be shown by a preliminary calculation whether a given galvanic battery can possibly heat a fine wire white hot, or whether it will fail to heat it hot enough to explode the fuse. His own experiments confirm the practice of some American constructors of torpedoes, in finding that both German-silver and platinum-silver alloys are greatly superior to platinum in regard to the resistance opposed to the passage of the electric currents, and consequently develop greater amounts of heat for wires of given lengths and diameters. German silver is superior in this respect to platinum silver. The most insidious cause of failure of electric fuses is found in the corrosion due to moisture; and for the construction of low tension fuses the wire must be selected which possesses the power of resisting corrosion when in immediate contact with the material of which the fuse is formed. In this respect German-silver wires, although inclosed in tubes, were found to deteriorate very slightly during the first forty days of their exposure, while platinum-silver wires in close tubes remained constant. When the gunpowder is wet, the German silver has much greater liability to corrosion. The charcoal is apparently that element of

the gunpowder which promotes corrosion. In general, the alloy composed of one third platinum and two thirds silver is superior both to the pure platinum and to the German silver; and this alloy has been admitted by the British Association Committee as the material for the reproduction of standards of electrical resistance. An alloy of platinum and iridium containing seven and one-tenth per cent. of the latter metal, proved as efficient in the protection of sensitive fuses as the finest silver platinum, and has moreover the advantage of being much stronger, and more reliable as regards uniformity of composition. It is, however, much less fusible than the platinum silver, so that the latter has the advantage when a large number of branch circuits of different lengths are to be fired simultaneously. The larger the percentage of iridium, the greater the resisting power of the alloy. An equally efficient material is found in an alloy of silver with twenty-five per cent. of palladium. The best method of constructing a fuse, so as to insure a thoroughly efficient priming, consists in preparing a very fine gun-cotton powder, by taking dry pulp gun-cotton, or compressed gun-cotton scraped off or broken up to powder, and sifting this through muslin. The dust thus obtained is intimately mixed, by means of a feather or hair-pencil, with sufficient mealed gunpowder, or detonating powder, to make it flow readily into a small cavity. When the breach of the fuse has been fixed in position, this priming-paper may be poured in, and made to surround it.

ORGANIZATION OF THE UNITED STATES BOARD FOR TESTING IRON AND STEEL.

The appointment of a government commission for the purpose of experimentally determining the strength and value of iron, steel, and similar materials for construction, has been referred to upon another page, in a note stating generally the objects which it was the problem of the commission to realize, and its *personnel*. In pursuance of the conditions of the act of appointment, the commission has met and organized the following standing committees to take charge of special branches of their work, viz.:

On Abrasion and Wear (A): R. H. Thurston, C. E., chairman; A. L. Holley, C. E., Chief Engineer D. Smith, U. S. N.

Instructions.—To examine and report upon the abrasion and wear of railway wheels, axles, rails, and other materials, under conditions of actual use.

ON ARMOR PLATE (B): Lieutenant-colonel Q. A. Gillmore, U. S. A., chairman; A. L. Holley, C. E.; R. H. Thurston, C. E. *Instructions.*—To make tests of armor plate, and to collect data derived from experiments already made to determine the characteristics of metal suitable for such use.

ON CHEMICAL RESEARCH (C): A. L. Holley, C. E., chairman; R. H. Thurston, C. E. *Instructions.*—To plan and conduct investigations of mutual relations of the chemical and mechanical properties of metals.

ON CHAINS AND WIRE ROPES (D): Commander L. A. Beardslee, U. S. N., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To determine the character of iron best adapted for chain cables, the best form and proportions of link, and the qualities of metal used in the manufacture of iron and steel wire-rope.

ON CORROSION OF METALS (E): W. Sooy Smith, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Commander L. Beardslee, U. S. N. *Instructions.*—To investigate the subject of the corrosion of metals under the conditions of actual use.

ON THE EFFECTS OF TEMPERATURE (F): R. H. Thurston, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Commander L. A. Beardslee, U. S. N. *Instructions.*—To investigate the effects of variations of temperature upon the strength and other qualities of iron, steel, and other metals.

ON GIRDERS AND COLUMNS (G): W. Sooy Smith, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To arrange and conduct experiments to determine the laws of resistance of beams, girders, and columns to change of form and fracture.

ON IRON, MALLEABLE (H): Commander L. A. Beardslee, U. S. N., chairman; W. Sooy Smith, C. E.; A. L. Holley, C. E. *Instructions.*—To examine and report upon the mechanical and physical properties of wrought iron.

ON IRON, CAST (I): Lieutenant-colonel Q. A. Gillmore, U. S. A., chairman; R. H. Thurston, C. E.; Chief Engineer D.

Smith, U. S. N. *Instructions.*—To consider and report upon the mechanical and physical properties of cast iron.

ON METALLIC ALLOYS (J): R. H. Thurston, C. E., chairman; Commander L. A. Beardslee, U. S. N.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To assume charge of a series of experiments on the characteristics of alloys, and an investigation of the laws of combination.

ON ORTHOGONAL SIMULTANEOUS STRAINS (K): W. Sooy Smith, C. E., chairman; Commander L. A. Beardslee, U. S. N.; R. H. Thurston, C. E. *Instructions.*—To plan and conduct a series of experiments on simultaneous orthogonal strains, with a view to the determination of laws.

ON PHYSICAL PHENOMENA (L): W. Sooy Smith, C. E., chairman; A. L. Holley, C. E.; R. H. Thurston, C. E. *Instructions.*—To make a special investigation of the physical phenomena accompanying the distortion and rupture of materials.

ON RE-HEATING AND RE-ROLLING (M): Commander L. A. Beardslee, U. S. N., chairman; Chief Engineer D. Smith, U. S. N.; W. Sooy Smith, C. E. *Instructions.*—To observe and to experiment upon the effects of re-heating and re-rolling, or otherwise re-working, of hammering as compared with rolling, and of annealing the metals.

ON STEELS PRODUCED BY MODERN PROCESSES (N): A. L. Holley, C. E., chairman; Chief Engineer D. Smith, U. S. N.; W. Sooy Smith, C. E. *Instructions.* — To investigate the constitution and characteristics of steels made by the Bessemer and other modern methods.

ON STEEL FOR TOOLS (O): Chief Engineer D. Smith, U. S. N., chairman; Commander Beardslee, U. S. N.; W. Sooy Smith, U. S. N. *Instructions.*—To determine the constitution and characteristics and the special adaptation of steels used for tools.

The secretary of the board announces that special researches have been assigned to the committees of the board in the interval during which the regular work of the board is delayed by the preparation of the necessary testing machinery, and during such periods of leisure as may afterward occur. Furthermore, that the investigations will be conducted with critical and scientific accuracy, and will for a while consist in the minute analysis of a limited number

of specimens, and the precise determination of mechanical and physical properties, with a view to the deduction and enunciation of laws connecting them with the phenomena of resistance to flexure, distortion, and rupture. Subsequently the board will enter upon more general investigations, testing such specimens as may be forwarded to the president, or such as it may be determined to purchase in open market. Immediately upon the completion of the apparatus ordered, circulars will be published giving detailed instructions relative to the preparation of specimens for testing, and setting forth minutely the information which will be demanded previous to their acceptance.

Engineers, scientists, and manufacturers throughout the country are warmly urged to second the efforts of the commission by imparting any information in their possession. Those wishing to aid the work can procure the fullest information by addressing the secretary, Professor R. H. Thurston, Hoboken, New Jersey.

THE STRENGTH OF CEMENTS AND MORTARS.

Surgeon E. Nicholson, of Bangalore, India, says that having completed his cement-testing machine, he has made a series of experiments with a view of ascertaining what results are given by it, not only with the ordinary materials, brick, lime, and sand, but such new material as might be presented. These experiments, which have extended over a very considerable period, embraced a large range of substances, and are especially instructive in respect to hydraulic mortars and lime. He says that the addition of raw sugar (or *jaggery*) to the shell-lime mortars made at Madras has often been mentioned, but the *rationale* of its employment is generally not correctly given. By some the advantage of sugar is ascribed to its influence in retarding setting. By others it is stated that the bad qualities of fat limes may be, in some degree, corrected by sugar, as its influence is very marked in the first solidification of the mortar. Captain Smith says that mortars made of calcined shells have stood the action of the weather for centuries because of the mixture of *jaggery* in their composition. Mr. Nicholson's own experiments confirm those of Captain Smith in showing that, while some increase of strength doubtless attends the use

of sugar, it is not so great as has been supposed. The beneficial action of sugar is, he considers, to be found in the greatly increased solubility of lime in the saccharine solution. While water dissolves only about one tenth of one per cent. of lime, a moderately strong solution of sugar will dissolve as much as three per cent. It is evident that the desiccation of the sugar solution will tend to strengthen mortar by allowing the lime to crystallize. Ultimately the sugar probably becomes converted into carbonic acid and water, which circumstance tends to strengthen the interior of the mortar. In the case of mortar made simply of sand and fat limes, its slight strength is due almost entirely to simple association, and it is destitute of the setting principle possessed by the mortar of soorkee and fat lime. The strongest cement tested by him is that made of soorkee and lime (soorkee being a name given to an artificial *puzzuolana* made by pounding brick or other forms of burned clay). This cement is at least four times as strong as either pure lime or lime mixed with sand. Its cost is not greater than ordinary mortar, since it can be mixed with twice its volume of sand, and its plastic nature permits of joints being made with it, consuming less than half the quantity which would be used in the case of sand and mortar; so that it becomes advantageous to use fine bricks that have fairly true surfaces, fitting each other closely. The soorkee cement answers well for plastering; and, in order to shorten the time required by the soorkee cement to set, a process has been employed by Surgeon Nicholson for preparing the clay in some way which will render it more easily decomposable when mixed with lime.—*Prof. Papen on Indian Engineering*, 1875, 61.

CONSTRUCTION OF STEEL VESSELS TO RESIST PRESSURE.

Mr. Walter N. Hill, chemist to the Torpedo Station at Newport, states that in the course of their experiments it has been found necessary to pay especial attention to the construction of strong vessels for containing liquid carbonic-acid gas. This gas at the temperature of $-4°$ Fahr. exerts a pressure of 322 pounds to the square inch, but at 94° Fahr. its pressure amounts to 1200 pounds to the square inch. The first flasks supplied to the station by Mr. Lay (the inventor of the torpedo) were stated to have all been ex-

posed to a test of 2000 pounds hydraulic pressure, and were supposed to be sufficiently strong for the strains that they would be called upon to bear. The flasks having burst, however, in the course of the experiments of the first day, it became necessary to thoroughly examine the methods of construction. The holders, as made by Mr. Lay, were, it seems, at the higher temperatures of the contained gas, subjected to pressures such that the strain on the iron was more than one third, and sometimes one half the possible strength of the material. The chances of flaws in the metal, and the development of weakness under strain, are too great to allow of working so close to the limit. Soft iron, in fact, is not a good material for the construction of flasks to be submitted to great strains, which often increase suddenly. Two methods were proposed in making new flasks; one of which was the construction of a flask of copper deposited by electricity, thus getting a vessel without joints. The other plan contemplated the use of soft iron, but by a mode of construction which seems to be much better than the one employed by Mr. Lay. Subsequently a new and superior process was devised and adopted to the exclusion of all others, and this was the result of the combined skill of Messrs. Matthews and Hill. Experiments had to be made in order to find out the best methods of manufacture; but eventually flasks were made to contain liquid acid which proved entirely satisfactory. These are cylinders with round heads, each cylinder being provided with one valve in the centre of one head. When in place in the torpedo, the cylinders lie upon their sides, and a tube leads from the opening controlled by the valve into the interior of the cylinder, being there turned up against the upper side, and in this way only the gas can pass out when the valve is opened. Each torpedo is provided with four cylinders, two of them seven feet long, one five, and the other four feet long. The outside diameter of each is twelve inches. They are made of the finest sheet steel, nearly one twentieth of an inch thick, in successive layers which are firmly fastened together with pure tin. The cylindrical portions of the flasks are made by rolling up a sheet of steel, of the proper length, into a cylinder. Another sheet, somewhat longer, is rolled into a similar cylinder, which is slipped half over the length of the first. A third, fourth, etc.,

similar cylinders are then slipped successively over and into each other until one is built up as thick and as long as may be required. The flasks in question were made in four layers. The loose shells thus put together are fastened into a solid cylinder by means of pure tin, which is melted and worked in from the inside with the aid of gas blow-pipes. The particular diameter given to these flasks is less than that which would have been adopted had not Mr. Matthews had facilities for making this size only, he having been for a number of years engaged in making similar soda-water reservoirs of sheet steel soldered with tin. There would, however, be no serious difficulty in the way of making such cylinders of any required diameter. All of the flasks furnished by Mr. Matthews were to bear 2000 pounds to the square inch, and, in addition, an extra flask was ordered to be made exactly like the other, and to be tested to destruction. This flask gave way under a pressure of 3136 pounds. The rupture consisted of the tearing of the sheets irregularly without regard to the joints. The heads and the junctions of the heads to the body were not affected. In every respect this form of holder seems to combine strength with the assurance of freedom from hidden flaws.—*Pamphlet by W. N. Hill, Newport*, 1875.

THE THRUST OF EMBANKMENTS.

Professor Boussinesq has communicated to the Royal Academy of Belgium a theoretical essay on the elastic equilibrium of masses of powder, and on the pressure of earths devoid of cohesion. These investigations bear directly upon the question of the determination of the thickness necessary to be given to a wall destined to sustain the pressure of an embankment of earth. The problems in question were first resolved approximately by Coulomb in 1873, and very many distinguished inquirers have, since his time, occupied themselves with this important subject. Most of these have assumed the following hypotheses: viz., that the wall, when it is overturned, is borne down by a prism of earth, which with the wall slides over the remaining earth and the lower portions of the wall in a direction parallel to the plane of rupture. Coulomb's solution of the question dispenses with the above hypothesis, which is, in fact, generally inconsistent with actual experience, but assumes that at the commencement of the rupture of the

wall or earth there was an equilibrium existing between the friction of the components of the embankment and the pressure due to their weight. Boussinesq has, however, resolved the problem under the supposition that the embankment of earth does actually exert a pressure over and above that which is exerted by the friction, and that it is only because this pressure was superior to the resistance offered by the wall that the overturning has been able to begin; and he has determined, in general, the laws of the pressure exerted by embankments, or by any pulverulent matter in a static condition, which precedes the rupture of equilibrium. In his investigations he has considered all the pressure which can arise from, and to a certain extent depend upon, small deformations in every elastic atom of the mass. Pulverulent matter is, therefore, considered by him as another important form of matter, different from gas, solid or liquid, which under pressure evidently becomes endowed with a certain rigidity, like solids, but which, when it ceases to be compressed, becomes a fluid.—*Bull. Acad. Royale de Belgique*, 1875, 63.

PRESERVATION OF HARBORS AND ROADSTEADS.

The remarkable labors of Captain Cialdi, of the Italian Navy, relative to the theory of the movements of the water of the ocean during storms, and the effect of waves upon the transportation of material, altering the character of harbors, etc., having been previously noticed, we have now to record the appearance of a smaller work by him on the construction of the ports of the Mediterranean. In reference to Port Said, situated at the northern opening of the Suez Canal, he suggests that, instead of constructing two complete jetties, it would be better to have a large trough or opening in the longer one, in such a position that the currents thereby induced shall carry away the alluvial matter, and deposit it in another portion of the channel. Tessan, a member of the Academy of Science at Paris, having perceived the rationality of this suggestion, urged that it should be put to the trial; but it was not done, and already a great inconvenience has been felt in the filling up of the ship channel. The engineer in charge of the hydraulic works of the Canal Company proposes now to prolong his jetties, in order to regain the depth of twenty-nine feet of water; but in future years

it is evident that analogous conditions will prevail, and it will eventually be necessary either to resort to dredging or to adopt Cialdi's recommendation.

In his work on the Mediterranean ports, Cialdi has sought to determine the principal dimensions of the port that shall have a given annual tonnage. His formulas permit him to calculate very nearly the development of the quays and surface of the harbor, and that of the outer harbor or roadstead. As to the mode of construction, he discusses the relative convenience of systems whose foundations have solid stone blocks or loose masses. The latter has been often employed in France, especially for the moles at Cherbourg and the jetties of Marseilles and Algiers, where, in order to oppose the formidable action of the ocean, blocks of nine hundred cubic feet have been employed. This method has the inconvenience of requiring considerable time before the mass has entirely settled. This has been avoided in the construction of the port of Dover, in England, by placing the blocks in a regular position under the water by the aid of the derrick. In his plan for developing the harbor of Civita Vecchia, one of the most important commercial ports of Italy, Cialdi proposes to combine the two systems by employing two moles and a breakwater. At present this port has a jetty arranged like the grand dike of Cherbourg, allowing two entrances, so that, according to the prevailing wind, a ship can choose either the one or the other.—13 *B*, III., 198.

THE EVAPORATION OF WATER IN STEAM-BOILERS.

A number of experiments have been made by the engineers of the Northern Railway of France on the evaporation value of the different parts of a locomotive boiler divided into five compartments. Each compartment held seventy gallons of water, and was fed from a gauged tank by a special pump. The compartments themselves comprised the fire-box and four other smaller sections of tubing, each of them three feet long, with one hundred and seventy-nine square feet of surface, while the fire-box has seventy-seven square feet of surface. The results confirm the fact, already established by Williams and by Graham, that the evaporative performance of the tube surface diminishes rapidly with the distance from the fire-box. Havrez, by careful analy-

sis and by experimental data, establishes the following law: The quantities of water evaporated by consecutive equal lengths of tubes diminished in geometrical progression, if the distance from the source increased in arithmetical progression; from which it follows that the ratio between the quantities of water evaporated by consecutive equal lengths of tubing is a constant number. The point at which this law begins to prevail is that at which the radiation of heat from the fuel ceases, where heat is communicated to the water by conduction alone. And it appears from observations that in locomotive boilers the evaporation diminishes by nearly one half at each interval of one meter, or from yard to yard; in other words, the constant ratio is one half. For large boilers, Havrez concludes that the value of the ratio varies between 0.5 and 0.7, but for very small boilers it may fall below 0.5.—*Proceedings of Institution of Civil Engineers*, XXXIX., 398.

CARBONIC ACID FOR EXTINGUISHING FIRES IN MINES AND ON SHIPS.

The problem of the best method of extinguishing fires in coal-mines and on shipboard seems likely to have received a practical solution in recent experiments at the Torpedo Station at Newport, Rhode Island, as communicated to the *American Chemist* by Lieutenant Barber, of the Navy, who, after a careful consideration of the subject, is decidedly of the opinion that liquefied carbonic-acid gas is the only satisfactory, while at the same time perfectly efficient application.

His plan for treating fires on shipboard is to have a flask or flasks, about three feet in length and one foot in diameter, at some suitable locality on the spar-deck or elsewhere, containing about one hundred pounds of the gas in a liquid condition. From the top or upper side of the flask a small iron pipe is to be permanently fitted along the water-ways (or just under the main-deck) throughout the entire length of the ship. From this main pipe, at suitable intervals, are branch pipes at right angles to the main, passing down next the skin to every store-room and hold of the ship; so that each compartment of the vessel shall have its own pipe or pipes, reaching from its bottom to the main pipe at the spar-

deck. There is to be a cock in the main pipe near the gas flask, and one in each branch pipe near the main, any one of which can be turned from the spar-deck.

On the alarm of fire the hatches are to be battened down, the cock in the branch pipe leading to the compartment where the fire is discovered is to be opened, and also the cock in the main next the gas flask. The liquid gas, which is under a heavy pressure in the flask, passes out through the pipe in the form of vapor as soon as the pressure is relieved by turning the main cock, and is driven in an instant by the great pressure behind it to the compartment to which it is admitted. Arrived at this point, and being one and a half times as heavy as air, it fills the compartment from the bottom up, without being diluted with the air, and produces intense cold by its expansion at the same time; while the pressure with which it enters forces it into all the interstices in the cargo, driving out every particle of the air, which will all escape from the top, as no compartment on board ship is perfectly air-tight. Knowing, then, the cubic contents of any compartment, and the cubic space occupied by the cargo in it, sufficient gas can be admitted to render it absolutely certain that no fire can exist there without the necessity of opening the hatches to see if the fire is out, until such time shall have elapsed as to render it perfectly safe to do so. By shutting the cock in the main pipe the remainder of the gas is kept from vaporizing until such time as it may be required.

On arriving in port, the flask is disconnected from its pipe and sent to the gas manufactory, where it can be refilled in a couple of hours, and on being returned is set up and connected in its usual place. Should no fire occur, the apparatus can remain intact for an indefinite length of time, except to see that the cocks are in working order occasionally. The liquid is entirely non-corrosive in its character, and the vapor is not injurious to any class of cargo, while it is, perhaps, the only substance that will permanently suppress the most advanced state of combustion in a cargo of coal.

Lieutenant Barber remarks that, as is well known, carbonic-acid gas is the effective substance in the "Babcock" and other patent fire-extinguishers, but in them it is produced on the spot by the action of an acid on marble dust, or the

bicarbonate of soda, and the supply of gas is quite limited; and, before the machine can be used again, it must be cleaned out and re-charged. One pound of the liquid is equivalent to about eight cubic feet of pure gas; and any quantity can be carried, as already stated, and kept indefinitely for timely use.

Until lately the use of liquid carbonic-acid gas, on a large scale, has been prevented by two difficulties: first, the want of an apparatus capable of producing a large quantity in a short time and at a low cost; second, the want of suitable vessels to contain it at low temperatures. Mr. W. N. Hill, chemist of the Newport Torpedo Station, has devised an apparatus, now in successful operation, which produces forty pounds of liquid gas per hour, at a cost of only fifteen cents per pound. To contain the gas Mr. John Matthews manufactures steel flasks of about the dimensions mentioned, which weigh but little over three hundred pounds, and which have frequently been tested to two thousand pounds per square inch, hydraulic pressure. These are made of sheets of steel rolled up one within the other, the outer one being riveted, while all spaces between the sheets are filled with pure tin. Thinner flasks, consisting of only one thickness of one sixteenth of an inch of sheet steel, are made by Mr. Matthews for soda-water purposes. They are carried constantly about the city of New York, and not one, so far, has burst.

Lieutenant Barber states that Mr. Hill is about publishing a work which will give a full description of the manner of preparing the gas and of applying it; as also the method of forming the flasks and fitting them for the required application.

It is quite probable that this principle will, in time, be adopted for extinguishing fires in burning buildings, as more effective in quicker time, and involving no damage from water.—7 *D*, *May*, 395.

SUCCESSFUL SCIENTIFIC BALLOONING.

The French Society for aerial navigation decided that its programme during 1875 should consist principally of two aerial voyages with the aid of the balloon *Zenith*, containing three thousand cubic meters, the first voyage to be of long

duration and the second of great altitude. The latter voyage and its disastrous consequences have already been noticed, and, in fact, so preoccupied the attention of the world that we are apt to lose sight of the importance of its predecessor, whose duration of twenty-two hours and forty minutes places it among the most remarkable voyages on record. Throughout the whole of this voyage the members of the expedition carried on, without interruption, a series of observations, and executed numerous experiments. Departing from Villette on the 23d of March, at 6.20 P.M., the balloon carried five scientists, 1100 kilogrammes of ballast, and the instruments for observation. The determination of the altitude and the direction of the route was specially allotted to Sivel, who, by means of the plumb-line and a cord of 800 meters' length, which extended to the earth and kept the balloon always in a fixed direction, was able to observe their course satisfactorily by the compass. As is well known to aeronauts, the course of the balloon was a continued series of slight ascents and descents, the highest elevation reached being about 1800 meters, and the average altitude being about 1000 meters, except during the last six hours, when the altitude averaged about 500 meters. The course described by the balloon was very nearly toward the southwest, the entire path being some 573 kilometers. By means of an apparatus invented by Penaud, they were able, from their height in the air, to determine barometrically and continuously the velocity of their horizontal movements. This instrument is formed of a graded arc, around the centre of which an alidade moves. The observer sights, under an angle of 30°, some object visible on the earth in the direction of the march of the balloon. When this object has passed under the line of the alidade, the latter is moved to 60°, and the same object is observed until it is exactly past the alidade the second time. Another observer has meanwhile noticed the time elapsed between the two readings. By the aid of the two angles thus observed, and knowing, in addition, the altitude by the barometric readings, it is possible to compute by a simple trigonometric formula the velocity of the balloon. These observations, executed many times, gave very precise figures, which could be verified subsequently. In the morning, as soon as the sun had risen

above the horizon, the atmosphere, which was very dry, suddenly became charged with electricity, whose quantity diminished gradually with the increasing intensity of the sun's rays. During the latter portion of the journey, being in the neighborhood of the sea, the passage of the balloon from an upper to a lower current of air was made eight times successively. The lower current had apparently a depth of only 150 meters; the upper current, on the contrary, prevailed uniformly above this elevation, being always from the southwest to the north-northeast, and opposed to the lower current. In the early morning hours the temperature of the air was always found to be, at all altitudes, decidedly higher than at the surface of the ground.—13 *B*, III., 293.

AERIAL NAVIGATION.

Aerial navigation has in no country been more diligently studied and more perseveringly essayed than in France; and of those who have distinguished themselves in this line of invention Penaud is among the first. In a recent communication to *La Nature*, he gives a short sketch of the best of the various kinds of apparatus for mechanical flying. He states that the war of 1870, by its stimulating ballooning, has also turned the thoughts toward the brilliant future that possibly exists for artificial flying; and he hopes that France, which has given the balloon to the world, will also, in the end, put to shame the ridicule of those who disbelieve in artificial flying machines. These, as at present known, are classed under the three heads of helicopters, or the helix bird, aeroplanes, and orthopteres. The helicopters are sustained in the air by the aid of helices, whose axes vary a little from the vertical; their movement of translation may be brought about either by helices suspended from the others, or by the aid of special propelling helices. The orthopteres are surfaces, very nearly planes, inclined at a small angle to the horizon, and pushed horizontally by propellers which are in general helices. Finally, orthopteres have, as their principal organs, surfaces which have movements very nearly vertical, and frequently alternating; and under this latter system are classed the wings of birds, surfaces having movements like the tails of fishes. Among the many descriptions which he gives of the special inventions included

under these heads, he says that the first helicopter was that of Launoy and Bienverin in 1784. The instruments of this class invented by himself, and finally brought to perfection in 1871, would, when started in a horizontal position, at first descend slowly, then, with the velocity thus acquired, would rise, and describe a regular path at seven or eight feet above the ground, over a course of one hundred and fifty feet, enduring about eleven seconds. Some models have even maintained themselves thirteen seconds in the air, and described a path of two hundred feet, being as free as birds from all communication with the ground during their flight. The construction of the mechanical bird presents far more serious difficulties than the construction of the helicopter or the aeroplane. Marey, whose abundant researches on the subject of flight, walking, running, etc., are well known, constructed artificial insects in 1870, which rose and turned by means of their wings, but were assisted by compressed air driven from a force-pump. The improvements that were made in the following two years were remarked upon at the meeting of the Society for Aerial Navigation, in June, 1872, when two pieces of apparatus were presented, the one by Penaud, the other by Hureau de Villaneuve. A bird constructed by the latter had a remarkable power of wing, and at each stroke one could see the body rise. Unhappily the strokes were too few, and, occurring only once for every horizontal movement of one meter, it followed that the bird slowly descended like a parachute. The bird constructed by Penaud could not ascend vertically, but moved horizontally with great rapidity, elevating itself, at the same time, by means of a railing inclined at 15° or 20°. These first models were subsequently somewhat improved, so that another bird constrncted by Penaud took a long flight, in the course of which it successively elevated and lowered itself by a motion similar to that seen in the flight of many small birds. The present state of the question is perhaps best described by saying that, while we have models which show that something is possible, yet the difficulties in the way of passing from these up to such larger apparatus as is demanded in order that mankind may avail themselves of this mode of progression, are, at present, too difficult to be overcome. The helicopters and the mechanical birds seem, in fact, en-

tirely impossible to realize upon a large scale. In Penaud's opinion the aeroplanes are our only hope.

THE ADHESION OF LOCOMOTIVES TO RAILWAY TRACKS.

M. Moschelle, engineer-in-chief of the district railway of the Jura, states that ordinarily, after having determined the total tractive force which can be produced by the adhesion of any given locomotive to the rails of the track, engineers deduct therefrom a certain proportion as being required for the locomotive itself, and treat the remainder only as available for overcoming the resistance of the tender and other parts of the train. He, however, is of the opinion that engineers make this deduction on the erroneous assumption that the friction between the wheels and the rails has to overcome the resistance of all the moving parts of the engine, while he maintains, on the other hand, that it is the steam which overcomes this resistance, the adhesion of the engine not being called upon at all. He further directs attention to the fact that, by coupling a second pair of wheels to the locomotive, so as to turn them into drivers, not only is the adhesion available for traction increased by the effect of the weight upon the other pair of driving-wheels thus brought into play, but that the adhesion formerly employed to overcome the journal friction of these wheels is no longer necessary.—*Proceedings of Institution of Civil Engineers*, XXXIX., 347.

NEW ADAPTATION OF SCREW PROPULSION.

Rear-admiral Paynter, of the British Navy, has recently presented to the Royal United Service Institution his views concerning a new adaptation of screw propulsion to naval vessels, concerning the merits and advantages of which his own experiments, as well as the opinions of all who have considered it, seem to be highly favorable. The idea was first suggested by Mr. J. Buchanan, who took out a patent for certain features of his model. Several of the engineers and large ship-builders of Great Britain having expressed to Admiral Paynter their high opinion of Mr. Buchanan's ideas, he states that he has felt himself justified in presenting the matter as an important one to the attention of navigators and ship-builders. The main feature of the improvement

advocated by Admiral Paynter consists in placing the propeller of a screw-steamer amidships, or nearly so; the hull of the vessel itself being cut into for that purpose in such a way that the blades of the propeller in their revolution do not project to any important degree on either side of the hull, but do project below to an extent sufficient to take hold of the water and propel the vessel. The blades are so connected with a handle, worked by the pilot on the bridge, that they may, if necessary, be presented edgewise to the water, and thus have no effect in propelling the vessel, or may even be reversed so as to back the vessel, the shaft of the screw always maintaining the same direction of motion. The wheel which carries the blades on its circumference revolves entirely in still water in the transverse chamber, or well, built as near the centre of the ship as convenient. The bottom of the vessel for about thirty feet before and abaft of this chamber is built slightly concave, so as to enable the water to have free access to the blades of the screw as they grip the water. A vessel of forty feet beam could easily carry a twenty-foot wheel, and the wheel works at a lower speed and a less consumption of fuel in order to obtain the same results as a screw. The weight of the wheel acts as a fly-wheel to carry the engine over the dead points or centre, so that only one engine need be used on ordinary occasions. The arrangement here described gives a great gain, both in the weight of the vessel and the storage room. No matter how heavily the vessel pitches, there is nothing felt of the trouble so annoying in ordinary screw-steamers known as racing. The ship may roll and pitch in the roughest weather, without causing the blades for an instant to lose their grip in the water, or cease to exert their full power. When the wheel needs to be repaired in any way, the chamber in which it moves can be closed by sliding ports, the water pumped out of the chamber, and the parts carefully examined while the ship is under canvas.—*Journal Royal Military Institution*, 1874, 527.

UTILIZATION OF WAVES AS A MOTOR POWER.

Mr. Tower proposes a method of obtaining motive power from the motion of the waves of the ocean. A boat resting upon the ocean may be supposed to be acted upon by a variable vertical force, equal to the difference between the

constant force of gravity and the vertical component of the wave motion. For example, supposing the force of gravity for three seconds one fifth greater, and for the next three seconds one fifth less than its natural intensity, and suppose that we have a weight of five tons suspended by a spring, so that the spring will continue to exert a uniform upward force of five tons, no matter how far the weight moves up and down, it is clear that during the three seconds in which gravity is one fifth more than its normal intensity the five tons' weight will virtually weigh six tons, and will thus exceed the upward force with the spring by a downward force of one ton. Similarly, when the force of gravity is one fifth less, the weight will only weigh four tons, and the spring will then exert an unbalanced or upward force of one ton. If now, during the supposed interval, the weight moves downward through one foot, and during the minus interval it moves upward one foot, it is clear that during each of these intervals it will exert a force of one ton moving through one foot; that is, one foot ton. But if, instead of one foot, it moves through ten feet, it will exert ten times the power; that is, ten foot tons. Mr. Tower finds, from experiments with the model, that the best arrangement is by putting the weight on the end of a revolving arm, whereby a centrifugal force, with the wave motion, may be utilized as well as the rising and falling motion. If the weighted arm is compelled to assume successive angular positions, so that it is always at right angles with the force, it is evident that the force will be continually acting to cause the arm to rotate. When the vessel is descending, the weight is performing the upper half of its revolution, and is consequently exerting an upward centrifugal force; and when the vessel is ascending, the centrifugal force is pushing down and resisting the vessel's ascent.—12 *A*, XI., 410.

LIQUID CARBONIC ACID AS A MOTIVE POWER.

Mr. Walter N. Hill, chemist to the United States Naval Torpedo Station at Newport, has written a paper for the Naval Bureau of Ordnance on the experiments and practice, at the Torpedo Station, with liquid carbonic acid as a motor for certain varieties of movable torpedoes.

The use of compressed air has been for some time familiar

to the public; but there are several difficulties connected therewith, the principal one being its bulkiness, as large vessels must be used in order to get a sufficient amount of motive power, and torpedoes can only be driven in this manner for short distances, the air being used at a pressure of from 600 to 900 pounds to the square inch. The use of liquefied gas has the advantage that a much larger quantity of motive power can be stored in the same space; of the gases that may be liquefied, carbonic acid is the best. In the employment of this substance as a motive power for torpedoes, it becomes necessary to attach to the torpedo a reservoir containing the liquefied gas, under a great pressure, the escape of which propels the torpedo through the water. The liquefaction of the gas may be accomplished either by the aid of the pressure of the evolved-gas or by means of mechanical compression. The former method has been very generally employed in scientific experiments on a small scale. Thilorier's apparatus for this purpose has the advantage of simplicity, but is troublesome and wasteful of the gas. By the mechanical processes, all the gas generated may be condensed, and at less expense, although the first cost of the apparatus is considerable. The Lay apparatus used at the Newport Torpedo Station is based on the method of condensation by the pressure of the gas itself; and the experience with this confirms the previous opinion that condensation by the use of compressing pumps is much better.

After the apparatus provided with the Lay torpedo had become unserviceable for want of repair, a second one was prepared from specifications made by Mr. Hill, in which compressing pumps were employed. The pump used in this apparatus was designed and built by the Burleigh Rock Drill Company, and is a modification of their well-known air compressor. The compressor and the generator were finished in April, 1874, and are fully described in Mr. Hill's pamphlet. The novel and most important feature of the apparatus is the supplying the gas to the compressing pump at a high generating pressure. The pump has then only to compress this gas to a moderate extent to bring it to the liquefying point. One hundred pounds to the square inch is the average pressure of the delivered gas. Suppose now the pressure of liquefaction to be 600 pounds. Then the gas must be compressed

to one sixth of its bulk, whereas, if the gas had been drawn from an ordinary gas-holder at a pressure of 15 pounds, it would need to be compressed to the one fortieth of its bulk. The gain is, therefore, evidently very great, both in the saving of power and the avoidance of heat evolved by the compression. In order to test the power of the pump, it has been run at a pressure of 1000 pounds; but this is higher than is reached in actual practice. The first work with this apparatus was performed May 21 and 22, 1874, when 315 pounds of liquid carbonic acid were made in less than two working days, or about nine hours of actual pumping. Great difficulty was at first experienced in the construction of flasks for holding the condensed acid. The cost of making the liquid was estimated to have been, in one case, 24.92 cents per pound, and in another case 21 cents per pound. Probably, under more favorable circumstances, the cost would not be greater than 15 cents per pound. In every respect the new apparatus at the station has fulfilled all expectations. By it liquid carbonic acid can be prepared safely, rapidly, and cheaply in any quantity.—*Hill on Liquid Carbonic Acid*, 1875.

A MONSTER BLAST.

At Crarra Quarry, Cumlodden, England, one of the largest and most successful blasts ever witnessed in that quarter was fired off on Friday afternoon, February 12, the result of which was the dislodgment of upward of 30,000 tons of granite rock. A bore thirty feet long was made into the solid rock, from the end of which, running at right angles, was another bore twenty-five feet in length, making the form of a letter L (sometimes such bores extend in both directions from the main bore, making the form of a letter T). At the end of this bore was sunk another one ten feet deep, in which chamber was placed 5300 pounds of prismatic powder.

AN IMPROVED DRY DOCK.

The latest improvement in this line is the Tubular Floating Dock, made by Mr. Latimer Clark, of Leeds, England, in conjunction with Mr. John Standfield. The dock is formed by a certain number of tubes, running lengthways of the dock,

which have valves on their upper and lower sides: the upper valves being for the admission of air, and connected with a valve house; the lower valves for the admission of water. On the two tubes which are placed on the outside are flanges, which are placed on the upper side so that vertical tubes can be bolted to them. On these vertical tubes is placed a tramway, together with the houses containing the air pumps and air valves. The operation of the whole is as follows: The dock being sufficiently submerged, the ship is floated over it. The water valves are then opened, and the air valves closed; the air pumps are started and air forced into the tubes, thus displacing the water and lifting the vessel. The water valves are then closed, and the dock floats without any reference to the air valves. In order to submerge the dock, the lower or water valves are opened, the air escaping by the upper air valves at the valve house until the dock is sufficiently lowered. The advantages of this dock are the cheapness with which it can be built, the great strength attained by the use of cylindrical tubes, and the great facility with which it can be moved from one place to another, as occasion may require.

THE PROPOSED FLOODING OF THE SAHARA DESERT.

A report has recently been made by Captain Roudaire, charged by the French government with the investigation of the possibility of converting the interior of Algeria into a sea, to which enterprise frequent reference has been already made in our previous *Records*. An appropriation of $2500 was made by the National Assembly of France in 1874 for the special inquiry, and a commission was selected, of which Roudaire was placed in charge. The special object was to determine carefully, by leveling, the area that it was thought could be flooded by cutting away the barriers and introducing the water of the Mediterranean.

The party left Biskra on the 22d of December, and in a few days reached the station of Chegga, the altitude of which had already been determined in 1873. The work was prosecuted with great care, and continued until April, 1875, at which time the party returned to its starting-point, after traversing a distance of 650 kilometers.

The general result of the investigation went to show that

there was a superfice of 6000 square kilometers capable of inundation, embraced between 34° 36′ and 33° 51′ N. latitude, and 3° 40′ and 3° 51′ E. longitude. In the central portion the depth below the level of the sea varies from twenty to twenty-seven meters. None of the large and beautiful oases of Souf would be submerged, Debila, the lowest of all, being fifty-eight meters in altitude. In the Oued Rhir the very inconsiderable and valueless oases of Necira and Dendouga would alone be covered.

The fear had been expressed that the invasion by the sea of the Chott Melrir would produce an infiltration, and thus destroy a portion of the wells that fertilize the oases. There being a large number of the wells situated not only in the Souf, but in the region around and in the vicinity of the basin of depression, it was found that they were all, without exception, fed from a stream above the level of the sea.

It was not thought practicable to investigate the frontier of Tunis, and consequently only the western point of the Chott Rharsa could be examined. It was ascertained, however, that this chott was below the level of the Mediterranean, and that it has a decided inclination toward the Gulf of Gabes. It was also found that the deepest basins of the Chott Melrir and of the Chott Rharsa, although united by the Chott Asloudj, had no direct communication at the present time, being cut off by sand downs. The distance, however, between the two basins is but about twenty kilometers, and could be easily opened by a canal. The plan would be to fill the Chott Rharsa, and then unite it to the Chott Melrir by a section, by which the waters, in flowing through, would soon enlarge the passage to the necessary dimensions. The Tunisian and Algerian basins might be inundated successively, the time necessary for filling being notably diminished from the fact that during the first part of the operation the surfaces submitted to evaporation would be reduced by one half.

Captain Roudaire thinks the general problem of an interior sea will be solved as soon as the Tunisian portion is thoroughly investigated, its depth and the relief of the Isthmus of Gabes throughout its entire extent being necessary. This question, however, is not likely to remain long undetermined, as an Italian commission has been taking levels in

that part, and the cost of the work and the possibility, in an economical point of view, of carrying out the stupendous project will be decided. One thing may be considered as fairly settled, although heretofore not of much controversy, namely, the existence of a vast depression capable of being filled with water.

THE SUEZ CANAL.

The recent report published by the Suez Canal Company, bringing up the statistics of the canal to the beginning of April of the current year, is, in more respects than one, an instructive document. It shows that the prediction of those who favored the enterprise from its inception—namely, that its opening would in a few years revolutionize the trade of Europe and the East—has been practically realized in the five years that the canal has been thrown open to traffic. It gives, furthermore, the gratifying intelligence that the success of the canal as a commercial venture is no longer a matter of doubt and uncertainty, but an established fact, while to Americans the document will afford a substantial argument in behalf of the long-deferred interoceanic canal across the American isthmus.

The canal was open to navigation in December, 1869, since which time to April 1, 1875, 5236 vessels made the transit. Of these 4998 were steam-vessels, and but 238 sailing-vessels, the small proportion of the latter being ascribed to the danger and difficulty of navigating the Red Sea; 2863 vessels passed through from the Mediterranean, and 2373 from the Red Sea.

The statistics by years are herewith given, the figures denoting a steady increase of business: 1870, 489; 1871, 763; 1872, 1082; 1873, 1173; 1874, 1264. Up to the end of the first quarter of 1875, 455 vessels had made the transit, which gives an average of 1820 for the year. If the totals above given are divided according to the nationality of the vessels represented, it will appear that Great Britain was represented by 3602 vessels; France, 416; Austria, 303; Italy, 254; Turkey, 131; Holland, 123; Egypt, 100; Germany, 95; Spain, 63; Russia, 36; Portugal, 22; Denmark, 17; Sweden, 15; the United States, 10; Belgium, 9; Greece, 7; Japan, 4; Burmah, 3; and Peru, Tunis, and Zanzibar, each 1.

In 1870 the net tonnage amounted to 436,609 tons, producing for the company a revenue of 5,048,944 francs; in 1874 the tonnage reached 1,631,640 tons, producing a revenue of 24,748,900 francs.—1 *B*, *July* 25, 231.

THE CHANNEL TUNNEL.

The recent meeting of the British Association gave an opportunity for the discussion of this gigantic project, and the current of opinion was for the most part favorable to its feasibility, so far as the geological and engineering problems involved therein are concerned. With regard to the actual undertaking of the work, it appears to be admitted on all hands, in view of its enormous cost, and consequently its doubtful character as a financial venture, that it must be made a national work, and executed under the combined auspices of the English and French governments. The legislation looking to this mutual division of responsibility has been conceded by both governments involved in the undertaking, and the reports of the joint commission of English and French government officers now engaged in studying the problem will, in all probability, decide the question as to whether the Channel Tunnel is to be a reality. Sir John Hawkshaw, the president of the British Association, and one of the government engineers of the project, in the discussion before that learned body gave the scheme his decided approval.

ELECTRICITY FOR THE HEAD-LIGHT OF LOCOMOTIVES.

A series of experiments has lately been made by the Russian government with reference to the use of electricity for the head-light of locomotives, a battery of forty-eight elements making every thing distinct on the railway track to a distance of over 1300 feet.—6 *C*, *October* 29, 1874, 438.

M. TECHNOLOGY.

XEROGRAPHY, A MANIFOLD WRITING AND PRINTING PROCESS.

By the following process, devised by Hansen, it is said that about 100, or even 200, copies of a manuscript may be taken in ten minutes. In manipulation it is similar to that with oiled paper saturated with a pigment, except that in this case the colored paper is placed beneath, with the colored side uppermost, and upon it, instead of writing-paper, a sheet of firm, thin, very dry oiled paper is laid that will take up the color without absorbing it. There may be a pile of five, or even ten, such layers of alternate colored and oiled paper, and when it is written upon with a pencil or stylus, a copy in reverse will be formed on the lower side of each leaf of oiled paper. From each of these about twenty impressions can be taken by placing writing-paper in contact with each one, and subjecting the whole to the pressure of a rolling-machine, then removing the impressions, renewing the writing-paper, and subjecting the whole to somewhat greater pressure than at first; repeating the operation with increased pressure for each impression up to the twentieth. It is only the blue paper that will afford so many impressions, and it must be thin, and the color must be much more finely ground than it is usually found in the trade. The paper on which the impressions are taken must not be rough, nor should it be too smooth, and the first impressions should be made with the least possible pressure. The printing, copying, or even the lithographic press is not well adapted to this work. If only twenty copies are desired, an ordinary pen in writing will answer.—8 *C, September* 17, 1874, 332.

STAMPING-INK.

An excellent stamping-ink that dries rapidly and is free from grease may be cheaply prepared, according to Müller, by dissolving one part of crystallized so-called red aniline violet in 30 parts of alcohol, and adding 30 parts of glycerine to the solution. This colored liquid is poured upon the cushion and rubbed with a brush.—5 *C*, XXXVIII., 1874, 271.

A NEW PROCESS OF ENGRAVING ON COPPER.

The Hydrographic Office at Paris has begun a process of engraving on copper which promises by its rapidity and the moderation of its price to be very widely useful. It consists, in substance, first, in covering a plate of copper with a thin shell of adhering silver, upon which is spread a thin layer of colored varnish; second, in drawing thereon, with a dry point, the lines, topography, and lettering, precisely as one engraves with a diamond upon stone; third, in corroding the traces by means of the perchloride of iron.—6 *B*, LXXVIII., 1535.

SLATE FOR ENGRAVERS.

As a matter of interest to wood-engravers, we note the reported discovery that plates of polished slate may be used in wood-engraving as substitutes for box-wood. It is declared that such engraved plates will furnish over 100,000 impressions without loss of detail; and, further, that they will not warp, and are not affected by either oil or water. The one drawback which they possess, however, is the fact that they are readily scratched; an objection from which even wood is not entirely free.

FRENCH METHOD OF ENGRAVING ON WOOD.

A French method of engraving on wood consists in first covering the block with a layer of gelatin (0.39 grammes to 31 grammes of water) by means of a soft brush. When this coating is dry, it is covered, in the dark, with a solution prepared of (1) red prussiate of potash, 7.80 grammes; water, 62.20 grammes; (2) ammonio-citrate of iron, 9.10 grammes in 62.20 grammes of water. These solutions are mixed and filtered, and the mixture is kept in the dark. After the layer is dry, it is exposed under a negative from ten to twelve minutes, and washed with a soft sponge, when a blue image appears. If thus prepared the coating does not shell off under the graver.—5 *A*, *January*, 1875, 98.

GOLD, SILVER, AND BRONZE INKS.

Most of the gold and silver inks on sale are so wanting in brilliancy and fluidity, and retain their stickiness to such an extent after use, that shell-gold and shell-silver are generally

preferred, although less conveniently employed. According to Viedt, however, gold, silver, and bronze inks are prepared that afford beautiful results, and that flow freely, though slowly, from an ordinary steel pen, although better applied with a pencil. True gold-leaf, although undoubtedly the best for ink, is sometimes replaced, on account of its price, by mosaic gold or iodide of lead, but generally by false leaf. On account of the cheapness of silver-leaf, silver ink of inferior quality is but seldom made from false leaf, etc. Ordinary commercial bronze powders are employed for inks of other metallic tints. Besides true and false leaf, metals are to be had in the form of very fine powder, prepared from gold-beater's waste, by rubbing it through sieves. These, previous to the manufacture of ink, must be freed from fatty and other impurities derived from the skins by triturating them or the bronze powders on a glass or porphyry slab with just enough honey to form a thin paste, as carefully as possible, since the beauty of the ink depends greatly upon this operation. This paste is then boiled for some time in a glass beaker, with water rendered somewhat alkaline, and allowed to settle, and, after the liquid is decanted, the powder is well washed with hot water, and dried at a gentle heat. Different shades may be imparted to it by boiling it with water containing sulphuric, hydrochloric, or nitric acid. A sufficient quantity of the purified powder is triturated with a solution of one part of white gum-arabic, four of distilled water, and one of potash water-glass. In general, one part of metal to three or four of the liquid will answer, but less gold is required than silver, since it covers far better; and glazed paper, and paper of a dark shade, also require less metal than rough, or light-tinted paper. A stock of ink may be prepared at once, and is best kept in a shallow porcelain vessel, so that it can be thoroughly stirred before filling into smaller bottles. It is also necessary to stir frequently when using it, and it is preferable to mix the dry powder with the liquid just before using it. The water-glass plays an important part in increasing the lustre, protecting the tint from atmospheric influences, and preventing too deep a penetration into the paper, without much impairing the fluidity. The lustre can also be improved by gentle burnishing.

WRITING PIGMENTS OF ANCIENT MANUSCRIPTS.

The destruction of ancient codices and palimpsests by modern scholars has been exhaustively discussed by Hotz-Osterwald, of Zurich. He contends that modern philologists ruin the ancient manuscripts by improper reagents, or injudicious use of them, and asserts that, with the exception of the carbon inks employed on papyrus, the writing pigments of antiquity and the Middle Ages have scarcely been investigated. The dark to light-brown pigment universally used on parchment, hitherto a problem, he contends, upon historical, chemical, and microscopic evidence, is identical with œnocyanin, and was prepared for the most part from yeast, and was first employed as a pigment. Contrary to the general opinion, it contains no iron, except frequently simply accidental traces. After its appearance in Greece in the third century, it formed almost exclusively the ink of the ancient manuscripts, until displaced in the fourteenth century by the gallate inks, undoubtedly introduced by the Arabians. The reagents usually employed upon manuscripts are without exception either wholly or partially objectionable. First of all the well-known "Gioberti-tincture" (yellow prussiate of potash and hydrochloric acid) soon converts both ink and parchment into a blue powder. The metallic sulphides, generally pronounced perfectly harmless, also cause the writing to wash, and often render it illegible in a short time. On the other hand, yellow and red prussiate of potash with acetic acid are recommended, and it is said that successive treatment with solutions of them may be of service with most perplexing palimpsests. Sulpho-cyanide of potassium, however, although theoretically the best, when used with acetic acid causes such decided contraction of the parchment as to be useless in this way. The destruction of many old manuscripts, ascribed to the monks, he feels satisfied has been due to the physical properties of the papyrus, especially its attraction for moisture.—13 *C*, *March* 1, 1875, 321.

TO RESTORE OLD WRITING.

To restore writing upon parchment, or paper, which may have become faded or illegible by time, it is recommended to first go over the surface with a sponge and warm water,

then to pass over the written parts with a pencil moistened in a weak solution of sulphide of ammonium, which in the majority of cases will at once restore the legibility of the text. The success of the process depends upon the fact that the great majority of such old writings will be found to have been made with an iron ink, and the action of the sulphide consists in the production of a sulphide of iron with the traces of iron yet remaining thereon.

AN OIL-LAMP AS A SUBSTITUTE FOR THE MAGNESIUM LAMP IN PHOTOGRAPHY.

Van Tenac exhibited, in Paris, an oil-lamp with a burner so constructed as to admit a jet of oxygen directly into the interior of the flame. The light produced was perfectly steady, and so intense that the gas-flame appeared yellow by contrast. Although less actinic than the light of the magnesium lamp, it is suggested that, by reason of its uniformity, cheapness, and convenience of use, it may be employed by photographers for reproductions which need not be produced rapidly.—15 *C*, VI., 1875, 96.

COMPOSITION FOR NON-ACTINIC (AMBER-YELLOW) GLASS.

A yellow glass, suitable for photographic dark-rooms, that is said to be more beautiful, purer, and more brilliant in color than that colored with metallic oxides, can be made by employing dried cow's-dung as the coloring matter, in the proportion of one part by weight of the dried and sifted dung to sixty parts of the usual mixture for colorless glass.—13 *C*, *March* 1, 1875, 318.

ADVANCES IN PHOTOGRAPHY.

In a review of recent discoveries in photography, Meldola states that since the year 1842, when Becquerel photographed the whole solar spectrum, and Dr. Draper the violet, blue, and ultra red, no successful attempts have been made to photograph the red end of the spectrum. Becquerel's result was obtained by a film of silver iodide first exposed to diffused light, and then to the action of the spectrum, by which processes he was able to photograph the entire spectrum from the ultra violet to the ultra red. During the past year Dr. Vogel has demonstrated that, by varnishing the ordinary

bromide of silver plates with a dye of coralline we get the maximum of photographic action in the indigo and the yellow; and by using aniline green the maximum of activity in the indigo and red. Again, Becquerel has dissolved coralline in the iodized collodion film, and obtained similar results. The most remarkable action was observed in the case of chlorophyl, by the use of which a spectrum image of great length was obtained from the ultra violet to the green, with a weaker impression from the green to the red. Continuing these observations in connection with what has more recently been published by Lockyer, we find every reason to announce, as a probable law, that the optical observation of the bands of any chemical show the active rays for that chemical; and that therefore, by a proper selection of dyes, a sensitive plate may be prepared especially adapted to any or to all operations on the spectrum.—12 *A*, X., 282.

IMPROVEMENT IN THE MANUFACTURE OF STUCCO.

A stucco has recently been prepared as follows, under the name of French or English cement, which becomes unusually hard when slowly worked with water, and which, when mixed with pigments, as lampblack, ochre, etc., after complete hardening, can be polished to resemble marble: Gypsum, after having been calcined once, is immersed for a few minutes in a 10 to 12 per cent. solution of alum. Chemical analysis shows that the plaster thus prepared is exceedingly pure, and contains but little alumina or potash. The alum has been replaced very successfully by Landrin with water containing 8 to 10 per cent. of sulphuric acid, by placing the gypsum in it, after its first calcination, for a quarter of an hour, and then recalcining it. All organic matter is thus destroyed, and the plaster, besides being of most excellent quality, is pure white.—8 *C*, *November* 26, 1874, 422.

RED MARKING-INK FOR CLOTHING.

A red ink for marking clothes, which is not attacked by soap, alkalies, or acids, is prepared by Welger as follows: Enough finely pulverized cinnabar to form a moderately thick liquid is very intimately mixed with egg-albumen, previously diluted with an equal bulk of water, and beaten to a froth, and filtered through fine linen. Marks formed

on cloth with this liquid, by means of a quill, are fixed, after they have become dry, by pressing the cloth on the other side with a hot iron. The ink will keep in well-closed bottles for a long time without separation of the suspended cinnabar.—6 *C*, *September* 10, 1874, 368.

SUBSTITUTE FOR INK.

A substitute for ink has been devised by Dr. Jacobsen, of Berlin, which consists of points, like the leads of ordinary pencils, that can be fitted into holders. The writing at first very much resembles lead-pencil marks, but when moistened immediately assumes a violet tint, and then adheres to the paper like ink. As many as six good copies can be taken from it by means of an ordinary copying-press.—5 *C*, LI, 1874, 449.

THE HARDENING OF PLASTER OF PARIS.

Landrin distinguished three phases in the hardening of gypsum by watching its progress under the microscope: (1) the assumption of a crystalline condition by the calcined plaster in contact with water; (2) the solution of a certain portion of the crystal by the surrounding water; (3) the evaporation of a certain amount of water by reason of the heat generated in taking up the water of crystallization and the formation of a crystal, which effects the crystallization of the whole mass, just as a crystal in a supersaturated solution of a salt. During the first two phases no hardening takes place, and it is only after some time that the maximum degree of hardness is reached, and the amount of water then present is only double that in the ordinary hydrate or gypsum. A definite mixture of water and plaster, which hardened in ten minutes, was found to lose water gradually for eighteen days, until the above composition was reached, when there was no further loss of water.—18 *C*, *Oct.* 14, 1874, 648.

SETTING OF PLASTER OF PARIS, AND MIXTURE OF LIME WITH IT.

According to Landrin, the setting of plaster of Paris is retarded by any thing unfavorable to crystallization, as by the use of a large quantity of water, in which case, however, the mass becomes very porous; or better still, by the addi-

tion of gum, glycerine, glue, etc., in making up the plaster, when the viscosity operates against crystallization. The treatment of plaster with alum and sulphuric acid, as suggested by him, and which is the most advantageous, diminishes somewhat its affinity for water, and thus causes it to set more slowly. The minimum of water can therefore be used in making it up, and, since it is perfectly anhydrous, it combines with a larger quantity of the water than the common gypsum, dries more rapidly, and becomes very hard. He also found that the caustic lime contained in plaster, resulting from the presence of carbonate in the gypsum, exercises a favorable influence upon its setting when mixed with water, since it combines with a portion of the water, producing an elevation of temperature and more rapid setting, and imparts a hardness doubtless due to its conversion into carbonate in the air. Common gypsum, containing 10 per cent. of lime, is said to give very excellent results, as it can be readily smoothed, and resists atmospheric influences better than plaster alone. Landrin has even prepared cements containing as high as 75 per cent. of lime.—13 *C*, *November* 1, 1874, 1369.

COLOR OF CHINESE BRONZES.

A chemical examination of some Chinese and Japanese bronzes of an unusually deep color, exhibited in Paris in 1869, has shown the existence of a much larger percentage of lead than occurs in the ordinary bronzes, proving that it is to this substance that the special composition and color of the bronze is due. Where zinc was present in considerable quantity, it seemed rather to counterbalance the effect of the lead. An alloy, composed of 5 parts of tin, 83 of copper, 10 of lead, and 2 of zinc, proved to be exactly like the Chinese bronze, and identical with it in fracture and polish. When heated in a muffle, it quickly assumed the peculiar dead-black appearance so greatly admired in Chinese bronzes.—21 *A*, *Sept.*, 1874, 927.

ARTIFICIAL DECORATION AND HARDENING OF SANDSTONE.

The following process of artificially impregnating sandstone is said to be in successful operation at several German stone quarries. The stone operated upon is a porous sand-

stone, which readily absorbs water to a certain depth, and the treatment consists in the successive introduction of a solution of an alkaline silicate and of alumina. The result is the production of an aluminous silicate within the pores of the stone, which gives to the surface a considerable power of resistance. The solutions employed are soluble glass and sulphate of alumina. After the process is completed, the stone may be polished like marble, which it greatly resembles. Heated to a high temperature, the exterior layer vitrifies, and may therefore be colored or decorated according to taste. The coloration may even be obtained by simply mixing the desired pigment with one of the solutions employed.

PRODUCTION OF PATINA, OF DIFFERENT COLORS, ON BRONZE.

The attention of Christophle and Bouilhet has been specially devoted for several years to the difference in the color of bronzes, and the method of reproducing them. Their investigations were controlled by the conclusion, reached after numerous experiments, that the patina of bronze can only be permanent when it results from natural chemical reactions, and is not developed by varnish or corroding agents. As a result, they exhibited brown, red, orange-yellow, and black colors. They state that they were obtained upon the surface by reactions which cause the production of suboxide of copper in two molecular modifications, and also of sulphide of copper. The objects allow of a coating of varnish for protection, the chief condition of its successful application being the slowness with which it is done. The process, it is claimed, is practical and trustworthy, and it will reproduce the same three colors at any time. Addition of lead to the alloy is not necessary to produce the black patina, which under such circumstances has been found to be brittle and wanting in permanence.—14 *C*, CCXIII., 1874, 447.

PÂTE SUR PÂTE, A METHOD OF DECORATING PORCELAIN.

The following is from an account of this method of decoration given by Professor De Luynes, of the Conservatoire des Arts et Métiers, Paris. A faint drawing is first made on the article, completely formed in unbaked porcelain. All the details are then represented by means of a colored

mass, diluted with water to the consistency of paste. The composition of the latter must be similar in nature to that of the porcelain, and its degree of contraction must be the same, so that the subsequent heating does not cause them to separate. The oxides employed as pigments must be so refractory as to resist the temperature of the porcelain oven, and not be converted in it into colorless silicates, or a dead coloring. The selection of pigments is therefore very limited. The colored *pâte* is laid on by the artist with a brush, and he regulates the distribution by the drawing, and the manner of laying it on by the number and thickness of the coatings, according to the relation that the color of the mass and its thickness must have to each other in the finished article. The appearance of relief is produced partly by the brush, and partly by a variation in the number of coatings, and by the manner of laying them on, and may be still further heightened by the employment of an instrument with which a true relief is given. The article is subsequently subjected to all the processes of undecorated porcelain. While articles produced by this method, by the aid of some of the best artists, have been greatly admired, and although it may combine all the excellences necessary to the production of works of art, they must necessarily be very expensive, on account of the long and minute labor required of the artist, and the risk to which the article is subsequently subjected in the baking.—13 *C*, *Nov.* 1, 1874, 1368.

STARCHING LINEN.

The following is recommended by a German journal: Make a liquid paste with good fine wheat starch and cold water, and then stir in boiling water until a stiff paste is formed, and immediately add white wax, or stearin, say about one ounce of wax to a pound of starch (the exact proportions, however, in any case can only be determined by experience). If it is desirable that the linen should be very stiff, powdered gum-arabic may be added to the cold water with which the starch is mixed. The strained starch should be thoroughly rubbed into the articles after they have been well wrung out, after which they should be placed between dry cloths and passed through the mangle, and then

rubbed on an ironing-board in one direction with a soft rag, to distribute any lumps of starch. Collars, etc., should be ironed dry, with a hot iron and considerable pressure. The sticking of the iron may be prevented by drawing it, while hot, over wax, and wiping it with a rag dipped in salt.—15 *C*, XXIV., 1874, 380.

PASTE FOR PHOTOGRAPHS.

Paste prepared as follows is highly recommended by Tunny for photographs: Mix thoroughly 630 grains of the finest Bermuda arrowroot with 375 grains of cold water, in a capsule, with a spoon or brush, then add 10½ ounces more water and 60 grains of gelatin in fine threads. Boil, with stirring, for five minutes, or until the liquid becomes clear, and when cold stir in well 375 grains of alcohol and 5 to 6 drops of pure carbolic acid. Keep in well-closed vessels, and before use work up a portion carefully with a brush in a dish. It is said to keep for a considerable time.—15 *C*, XXIII., 1874, 357.

MUCYLINE, A COMPOSITION FOR OILING WOOL.

The so-called mucyline, for oiling wool, consists of sebacic acid, 19.8 lbs.; potash soap, 19.8 lbs.; glycerine, 11 lbs.; sulphate of zinc, 154 grains; and water, 55 lbs. The sebacic acid is carefully mixed with the glycerine, or instead of it with a vegetable or animal mucilage, and the soap is then added. The mixture is then diluted with 10½ quarts of water at 176°, in which the sulphate of zinc has been dissolved, and the rest of the water is then added very gradually, with continual kneading of the mass. The very tough, homogeneous paste thus formed can be kept for two weeks, or even longer, and the mucyline, which is a liquid of a density 1.025, may be prepared from it, by adding to 35.2 lbs. of it 39.6 lbs. of water, either cold or warmed to 68°–77°, according to the season, and filtering the liquid or allowing it to settle.—32 *C*, *April* 10, 1875, 174.

WATER-PROOFING COMPOSITION FOR BOOTS.

A mixture made as follows is said to render leather water-proof and pliable, as well as far more durable, and at the same time does not prevent its taking ordinary blacking:

Take three parts of green cart-grease, one of lard, and half a part of common comfrey. Chop the latter quite fine, and boil to a thick paste with water, and free it from fibres by straining. If the leather is very hard, more comfrey should be taken. Before the application of the mixture, the boots should be rendered pliable by moistening them with warm water, and after they are thoroughly coated with it, especially the soles and seams, they should be allowed to dry slowly in the sun or near the stove. The operation should be repeated every two weeks, at least upon the soles and seams. —26 *C*, IV., 1875, 37.

RAPID BLEACHING OF LINEN.

According to the experience of some, time may be saved by bleaching linen by the following process: Rub the linen as it comes from the loom, in a dry condition (best on a table), with a brush, with a lather of soap made by boiling 1½ lbs. of soap for a piece of coarse linen, or 1 lb. for a piece of fine, and allowing it to cool; then cover the linen in a tub with a cloth. Prepare a lye, for a piece of linen, by boiling half a bushel of good sifted beech-wood ashes in rain or spring water, and filtering it through a lye-basket; bring it to boiling in a clean kettle, and pour it upon the linen. Cover the vessel well, so that the warmth and moisture may be retained as long as possible, and allow it to stand overnight. Spread the linen on the grass in the morning, see that no spots become dry during the day, and cover at night again with the boiling lye. Turn the linen out the second day, and expose as before, without allowing it to become dry, and steep it overnight in weak hot soap-suds in a well-covered vessel. Wash out the dissolved dirt in the morning, and expose again, without allowing it to dry before evening, and then treat in the usual way until it is as white as may be desired; six to eight days often being sufficient. If necessary, however, the soaping and steeping may be repeated as before, when only two days additional bleaching will be required.—9 *C*, *July*, 1874, 102.

RAPID BLEACHING PROCESS.

The following processes are given by the *Muster-Zeitung:* The washed material is steeped from six to twelve hours, ac-

cording to its character, in a weak bath of 5½ to 7½ lbs. of chloride of lime to 26½ gallons of water, and, after being washed, is boiled from two to four hours in a bath of 23 ozs. of soda to 26½ gallons of water. If the fibres are very firm the material is dipped, previous to boiling in the alkaline bath, in a bath containing 6½ lbs. of sulphuric acid, and then allowed to drain well. After treatment in the soda bath the stuff is washed, and immersed from four to six hours in a warm or cold bath of 5½ to 7½ lbs. of chloride of lime and 24¾ ozs. of soda to 26½ gallons of water, and then washed. Another process consists in employing a chlorine bath, containing excess of alkali, prepared by the incomplete saturation of lye with chlorine, or by the decomposition of chloride of lime by excess of alkaline carbonate. For linen, hemp, and cotton the excess of alkali should be 5 per cent.; for jute and other substances that are difficult to bleach, 25 per cent., varying with the temperature, which should not exceed 122°, the lower temperatures requiring more alkali.—26 *C*, XIII., 123.

REMOVAL OF STAINS OF NITRIC ACID FROM WOOLEN GOODS AND THE FINGERS.

The yellow stains made on brown or black woolen goods by nitric acid can be removed, when freshly formed, by moistening them repeatedly with a concentrated solution of permanganate of potash, and then rinsing with water. Yellow stains on the hands may be treated in the same way, and the dark-brown coloration produced may then be removed by treating with aqueous solution of sulphurous acid. —5 *C*, LI., 1874, 408.

CHROME-YELLOW, OR GREEN UPON INDIGO GROUND, ON COTTON.

The *Muster-Zeitung* recommends the following: Add 2.2 lbs. of sulphate of lead to 21 pints of water, and slake in it 6.6 lbs. of quicklime, and stir it well into 53 gallons of water, and allow it to clear. Mordant twice in the clear liquid, allow the stuff to drain, and, after half an hour, dye yellow in chromate of potash.—25 *C*, XIX., 1875, 150.

DYEING FEATHERS GREEN.

A German journal recommends a bath prepared by adding to a decoction of turmeric, indigo-blue, and slaked lime ac-

cording to the shade desired. The feathers may also be removed, and more blue be added, if it is found desirable. They must be washed in a number of changes of water, to the last of which some cream of tartar should be added.—25 *C*, XIX., 1875, 150.

WHITENING WOOL WITHOUT SULPHUR.

In whitening wool according to the following process, the proportions given must be so modified, to suit the quality of it, that the fibres do not become harsh and brittle; the latter evil may, however, also be avoided by placing the wool, on its removal from the sulphuric-acid bath, in luke-warm water, containing a few crystals of soda. The wool is placed for an hour in a kettle containing, for 33 lbs., about 52 gallons of hot water, and 4½ lbs. of carbonate of baryta. It is then removed to a new hot bath, of the same volume, containing about 3 pints of sulphuric acid, to which a few drops of aniline-blue soluble in water may be added.—5 *C*, XIX., 1875, 152.

COLORING COPPER ALLOYS AND SILVER A DEEP BLACK.

According to Paul Weiskopf, any alloy of copper, or silver alloyed with copper, may have a deep black, permanent film, that will endure polishing with leather and oil, formed upon it by rubbing it hard with the tip of the thumb slightly moistened with deliquesced bichloride of platinum. The process may be considered inexpensive, in spite of the price of the bichloride, since so little of it is required, and the manipulation is so simple.—14 *C*, CCXV., 1875, 470.

PURIFICATION OF HYDROCARBONS EMPLOYED IN DRY OR CHEMICAL CLEANING.

Dr. Vohl, of Cologne, contends that the purification, with sulphuric acid, of benzol, etc., that has been employed for cleaning garments, is not to be recommended, since sulphurous acid is formed by the action of the organic matter, and this is taken up by the hydrocarbon, and may injure the color, and even the fibre of linen and cotton, in its subsequent use, unless it is removed by an alkali. Besides, an alkali, or alkaline carbonate, is the proper reagent for the removal of the fatty acids that form a portion of the impuri-

ties removed from the garments. He suggests, therefore, treatment of the impure liquid first with dilute soda solution, and then distillation with steam in a peculiarly constructed apparatus, which he describes, which acts continuously, and with which from 2000 to 2500 quarts can be purified in twelve hours, dependent on the boiling point of the hydrocarbon. The distillate is desiccated.—14 *C*, CCXIII., 1874, 399.

VIOLACEIN, A NEW BLUE DYE-STUFF.

The following process has been patented by Gottheil, in England, for the preparation of a dye-stuff, which is said to afford a permanent dark-blue color with a slight copper-red lustre. Products resulting from the distillation of tar are stirred with enough of caustic potash to impart a slight alkaline reaction, and the mixture is then washed with water, and again distilled. The oils passing over at about 347° are then washed with a weak lye, to remove carbolic acid and creosote, and are afterward mixed with a strong solution of caustic potash, and oxidized by any of the usual methods. The dye-stuff thus produced is separated by filtration, washed, and dissolved in an acid. Caustic potash is then added to the filtered solution, and the precipitate formed is washed in alcohol, and finally dried. It is entirely insoluble in alkalies, alcohol, or soap solution, but forms a red solution with dilute acids.—6 *C*, *March* 25, 1875, 118.

STAMPING-INK, FOR COTTON AND LINEN, UNAFFECTED BY CHLORINE.

An ink suitable for marking cotton and linen goods, that are to be bleached, may be prepared by diluting one part of coal-tar with one of benzine, and stirring in one tenth of a part of lampblack, until a homogeneous mass is formed. It should be dried after stamping, and may be rendered thinner or thicker by varying the quantity of benzine. — 24 *C*, XVI., 1875, 124.

DYEING HORSE-HAIR.

Horse-hair may be dyed as follows: *Brown:* The hair must first be thoroughly cleansed by placing it in a soap bath, heated to 133°, for twenty-four hours, and moving it

about frequently. It must then be allowed to lie for twelve hours in a dye bath, prepared from a decoction of logwood with lime-water at 122°, and then be rinsed and dried. *Blue, inclining to violet:* The hair must first be dyed brown, as just given, and then passed through water, to which a little of a solution of 10½ ozs. of tin in 35¼ ozs. of hydrochloric acid has been added, and then washed as in the previous case. *Blue:* The hair must be prepared in a solution of two parts of alum and one part of tartar, wrung out, and passed into an indigo bath, prepared with fuming sulphuric acid, and then rinsed and dried. *Red:* The hair must be prepared by placing it for half an hour in a tin salt bath, prepared like that for violet blue; after wringing it out it must be dyed with Brazil-wood, to which some alum has been added, allowing it to remain in the dye-bath for twenty-four hours, and then rinsing and drying it.—5 *C*, XLVIII., 1874, 384.

NEW BLACK PRINTING COLOR.

According to Knaffl, if vapor of turpentine is passed over sesquioxide of iron (*Colcothar vitrioli*) at a red-heat, a black pigment results, surpassing printing-ink in softness, lightness, and depth of color, and said to be adapted to printing from stone, copper, and steel.—13 *C*, *November* 1, 1874, 1370.

NEW AND DURABLE COLORS.

Durable colors can be prepared economically, according to *The English Mechanic*, by mixing small portions of sulphate of iron, nitrate of manganese, and nitrate of cobalt or sulphate of copper with a solution of sulphate of zinc. The mixture is then reduced to dryness, and subjected to sufficient heat to drive off the sulphuric acid. The colors prepared by this process are yellows, greens, grays, pinks, and gold.—19 *A*, *October* 16, 1874, 118.

IODINE GREEN ON WOOLEN YARN.

According to the *Deutsche Färber-Zeitung* the mordant for iodine green on woolen yarn is prepared by adding 40 lbs. of purified hydrochloric acid and 50 lbs. of hyposulphite of soda to 225 lbs. of soft water, and allowing it to settle. For 20 lbs. of wool, 40 lbs. of this mordant is heated to 158°, and the yarn is well worked in it, with constant

turning for half an hour, and is then wound out, and the bath is again heated to 158°, and the yarn worked in it again for the same length of time, and removed, and well cooled and allowed to lie overnight. It is to be rinsed shortly before dyeing, which is done according to sample, in a clear bath, by means of iodine and picrine, wooden vessels being employed throughout the whole operation.—26 *C*, XVI. 1874, 155.

IMPROVED CHROME GREEN.

Practical chemists have, for a long time, had their attention directed to the problem of manufacturing permanent greens, otherwise than as combinations of arsenic; and it is now announced that a very fine and intense chrome green can be prepared by heating a mixture of equal parts of sulphur and bichromate of potash to redness in a crucible. The product is then to be leached with hot water, which dissolves the sulphide and sulphate of potassium produced, and leaves the oxide of chromium as a fine powder of an intense green color.—18 *A*, *October* 16, 1874, 118.

BEHAVIOR OF ANILINE COLORS TOWARD INFUSORIAL EARTH.

According to Böttger, after shaking an alcoholic solution of any aniline color with a sufficient quantity of infusorial earth, and then adding some water to the mixture, and bringing the whole upon a paper filter, the filtrate will be found to be perfectly colorless, the coloring matter being retained by the earth.—15 *C*, XVI., 256.

NEW DYES OF CROISSANT & BRÉTONNIERE.

A very important advance in the art of dyeing has been made by the discoveries of Messrs. Croissant & Brétonniere. These consist in the treatment of certain organic substances, such as wood, sawdust, lichens, moss, gluten, starch, sugar, tannin, gelatin, blood, horn, soot, sundry acids, and alkaline solids, resins, etc., by means of certain sulphides, at a more or less elevated temperature. The process of manufacture is very simple and inexpensive, according to Messrs. Wirth & Co., at Frankfort-on-the-Main, not exceeding $10 per hundred pounds; the profits being much greater than those from the manufacture of aniline colors. The new dyes comprise

shades of brown, yellow, and gray; some tints of lilac and violet, and a color very nearly approaching black. They are not very brilliant compared with aniline dyes, but have a peculiar warmth of tone which makes them especially suitable for fashion colors. In combination with the wood and extract colors, as well as with the aniline dyes, very beautiful new shades are obtained. They are generally of much greater intensity than most natural dyes, and they are soluble in water, and adhere to the fibre without any mordant, although they are usually fixed by bichromate of potash. They surpass in durability any known dyes, being not in the least affected by either strong acids or alkalies.—1 *A*, *October* 9, 1874, 170.

ANTISEPTIC AND PHYSIOLOGICAL EFFECTS OF SALICYLIC ACID.

Investigations by Professor Kolbe indicate that salicylic acid, like carbolic acid, restrains or even prevents fermentation and putrefaction, and possesses general antiseptic properties. Thus the addition of $\frac{1}{1000}$, or even less, of the acid to a solution of grape-sugar, prevents entirely the action of yeast upon it. A very slight quantity added to milk keeps it sweet for a long time, without being perceptible to the taste. Fresh meat treated with it has been found to keep well in the air for weeks, and its possible use in the preservation of meat is suggested. Experiments made in the Leipsic Hospital, by strewing it, either alone or mixed with starch, upon contusions and cancerous surfaces, showed that it destroys the fetid odors without producing perceptible inflammation. Likewise in amputations and in other cases it was used with such results as to justify the hope that it may be found in surgery to have all the desirable properties of carbolic acid without its objectionable ones, and that it may also be found efficacious as a remedy in certain classes of diseases. Experiments with it by administering it internally, or by external application, in cases of incipient cholera, are suggested. —14 *C*, CCXIII., 1874, 165.

IMITATION OF WALNUT.

The following is said to be a very superior method for staining any kind of wood in imitation of walnut, while it is also cheap, and simple in its manipulation. The wood, pre-

viously thoroughly dried and warmed, is coated once or twice with a stain composed of one part, by weight, of extract of walnut-peel, dissolved in six parts of soft water by heating it to boiling, and stirring. The wood thus treated, when half dry, is brushed with a solution of one part, by weight, of bicarbonate of potash in five parts of boiling water, and is then allowed to dry thoroughly, and is to be rubbed and polished as usual. Red beech and alder, under this treatment, assume a most deceptive resemblance to American walnut. The color is fixed in the wood to a depth of one or two lines.—15 *C*, XX., 1874, 313.

ON PAINT AS AN ENGINEERING MATERIAL.

In a paper on this subject read before the Society of Engineers by Mr. Ernest Spon, the author remarked, in reference to the composition and characteristics of the pigments usually employed, that white-lead should be of good quality, and unmixed with such substances as chalk, sulphate of lead, and sulphate of baryta. Zinc white he considers not so objectionable as white-lead, but proves to be dry under the brush and takes longer in completely drying. Red-lead is durable and dries well; but antimony vermilion is capable of being substituted to advantage for red-lead. Black paints from the residual products of coal and shale-oil manufacture and oxide of iron paints are generally used for iron work, for which purpose they are peculiarly suited. He concludes, upon the whole, that no better protection for iron-ore structures can be had than oxide of iron paints. The real value, however, of any paint depends upon the quality of the oil, the quality of the pigment, and the care bestowed on the manufacture. The superiority of most esteemed paints is due to this process rather than to any process or material employed in the preparation.—*Iron, May* 8, 1875, 587.

VARNISH FOR IMITATING GILDING ON BRASS AND BRONZE.

A beautiful imitation of gilding on brass and bronze articles may be effected by means of a varnish composed of 160 grains of gum lac, 40 grains of dragon's-blood, 10 grains of turmeric, and 3320 grains of alcohol. The metal should be brushed with the varnish, in all directions, by means of a sponge, and then immediately warmed over a gentle charcoal fire. The

surface at first will appear dead, but will soon resemble the finest gilding. The varnish should be kept in well-closed vessels.—5 *C*, XIII., 1875, 104.

GOLDEN VARNISH FOR LEATHER.

This varnish, employed in imparting to leather a lustre resembling that of the golden beetle, by simply brushing it on with a broad brush, according to investigations of Böttger, consists of a somewhat concentrated solution of fuchsin in an alcoholic solution of shellac.—14 *C*, CCXIII., 1874, 531.

PREVENTION OF YELLOWING OF WHITE PAINT.

Dr. Lüdersdorff, of Berlin, regarded the oil employed as the sole cause of the yellowing of white paint, when light and air are excluded; and since the oil acts simply by reason of its conversion, by oxidation, in drying, into a peculiar resin, which forms the sole binding material of the pigment, and renders the paint durable, he suggested a solution of some colorless resin as a substitute for oil in the preparation of white paint; and it was found, on trial, that a coating of white paint prepared on this plan remained unchanged in color after two years and a half. The number of resins adapted to this purpose is not as great, however, as might at first be supposed, since they must be colorless, especially for white paint, and hard enough to form a durable paint, and at the same time cheap enough, and should not require too expensive a solvent. Shellac, one of the very best in these respects, however, has the peculiarity of acquiring a reddish tint with carbonate of lead, unless it is bleached, in which form it is too expensive. Gum copal is not only expensive, but requires an expensive solvent. Rosin is too brittle, except perhaps in cases where a great degree of hardness may not be required. Sandarac, one of the hardest and least colored resins, and dammar were however found to answer. Among the solvents, alcohol and oil of turpentine alone were found of practical value, though not capable of substitution for each other; thus copal, shellac, and sandarac require alcohol, and dammar turpentine, and while rosin is soluble in ether, it will only dry rapidly enough when used with alcohol. For sandarac solution, 7 ounces of the gum, carefully freed from pieces of bark, etc., and 2 ounces

of Venice turpentine, covered with 24 ounces of alcohol, of a specific gravity of 0.833, are heated in a suitable vessel, with continued stirring, over a slow fire or spirit-lamp, near but not quite up to the boiling point, and the solution is completed by retaining the mixture at this temperature for an hour, with frequent stirring. The varnish can be employed immediately after cooling for mixing the paint. The Venice turpentine prevents too rapid drying of the paint, and consequent difficulty in spreading it. A weaker alcohol will not only dissolve sandarac with difficulty, but is also liable to become so dilute, by evaporation, as to cause a powdery precipitate of the gum, and prevent the formation of an adherent film. The white-lead to be used with this varnish is first finely ground with water, and dried, and then again ground with a muller with barely as much turpentine as the operation requires. The varnish will not answer for this operation, because it dries too rapidly, but the mass thus obtained is stirred with as much varnish as is necessary to form a paint that will spread readily; about one pound of white-lead being required to half a pound of varnish. As it dries quickly it must be applied rapidly, and without passing the brush over partially dry portions. In course of half an hour a second coat may be laid on. One peculiarity of this paint deserving of notice is that it thickens so much in the vessel from which it is used that it will not spread well, a difficulty that may be remedied by thinning it, not with alcohol, however, as might be supposed, but with a little of the varnish, since the thickening is not due to the evaporation of alcohol, but to a peculiar chemical action of white-lead upon the sandarac. If the color is wanting in lustre when dry, too much varnish has been employed, but a fine, agreeable polish may be imparted to it, when perfectly dry, by rubbing with a woolen rag. Paints with oil of turpentine are just as easily prepared, but the choice of resins is far more restricted, and the proportions are different from those with alcohol. Dammar is found to answer every requisite of hardness, cheapness, and freedom from color. Eight ounces of the crushed gum are heated with 16 ounces of oil of turpentine to 167° to 190°, and kept at that temperature, under continued stirring, about an hour, until solution is complete. The varnish is decanted on cooling, and pre-

served for use. The color is dead, however, even with two coats, and does not receive a polish as readily as that with alcohol varnish. A gloss may be imparted by coating it with the pure varnish, to which half its weight of oil of turpentine has been added, or better still by coating it with sandarac spirit-varnish, since sandarac is harder than dammar alone, and the article will therefore endure handling longer. The elasticity of these paints is less than that of fresh oil paints; but this quality is easily dispensed with in painting inner doors, window-frames, etc.—15 *C*, VII., 1875, 97.

KEKUNE OIL, OR HUILE DE BANCOUL.

The oil from the nuts of the *Aleurites triloba* (they contain 50 to 60 per cent.), which is found in the European market, though not regularly, under the name of Kekune oil, or *huile de bancoul*, deserves, according to Dr. Wiesner, more notice from oil manufacturers, not only on account of its cheapness (as it can be produced in large quantities in Guadaloupe, New Caledonia, etc.), but also on account of its quality. It belongs to the drying oils, and is said to be remarkably well adapted to the preparation of oil paints, and if it also prove adapted to the manufacture of printing-ink, at less cost than that from linseed-oil, its introduction for that purpose will be very desirable.—6 *C*, *July* 30, 1874, 308.

OIL FROM THE CARAPA-TREE.

Attention has lately been called to the commercial value, for oil-producing purposes, of the Carapa-tree (*Carapa guyanensis*). This plant abounds in French Guiana, especially in the district of Cachipour, where it forms vast forests. The fall of the nuts extends from February till June, and they are so abundant that the soil for many leagues in extent is covered with them to a depth of several inches. If collected and pressed during this period, they yield about 35 per cent. of an excellent oil. The price at Cayenne is estimated at about $25 to $30 per ton.—17 *A*, *October* 1, 1874, 151.

VASELINE, A NEW PETROLEUM PRODUCT.

A new petroleum product has been introduced into the trade under the name of Vaseline, which, according to *The*

English Mechanic, promises to be useful as a vehicle for emollient preparations. It is a solid, semi-transparent jelly, free from taste or odor, and becomes liquid at 93° Fahr. It is obtained by evaporating crude petroleum, and filtering the residue through animal charcoal.—18 *A*, *Sept.* 25, 1874, 36.

TINNING VARIOUS METALS IN THE HUMID WAY.

The following method is given by Wegler: A solution of perchloride of tin is first prepared by passing washed chlorine gas into a concentrated aqueous solution of tin-salt, and expelling the excess of chlorine by gently warming it, then diluting it with eight to ten times its volume of water, and filtering it, if necessary. The article, well pickled in dilute sulphuric acid, and polished with sand and a steel scratch-brush, and rinsed with water, is loosely wound with a zinc wire, and immersed for ten or fifteen minutes, at the ordinary temperature, in the dilute solution of perchloride of tin. When tinned in this way, it is rinsed, brushed with a scratch-brush, dried, and finally polished with whitening. This applies to tinning cast iron, wrought iron, steel, copper, brass, lead, and zinc.—13 *C*, *November* 1, 1874, 1368.

GILDING GLASS.

The following process for gilding glass has been patented by Professor Schwarzenbach: A filtered solution of perfectly pure chloride of gold, in boiling water, is diluted until twelve cubic inches of the liquid contain one grain of metallic gold, and is then rendered alkaline with caustic soda. As a reducing agent, alcohol saturated with marsh gas, and then diluted with its volume of water, is employed. One and a half cubic inches of this liquid are added to the alkaline gold solution, and the mixture then poured between the plate to be gilded (previously well cleansed) and a glass plate placed about one tenth of an inch below it. After remaining undisturbed from two to three hours the gilding is complete, and the glass is removed and washed.—16 *C*, *November* 26, 1874, 428.

NEW PHOSPHOR-BRONZES.

Dr. Kunzel, whose name will be recalled as the joint discoverer, with M. Montefiore-Levy, of the well-known phos-

phor-bronze, now announces the additional discovery that when phosphor-bronze is combined with a certain fixed proportion of lead, the phosphorized triple alloy, when cast into a bar or bearing, segregates into two distinct alloys, one of which is hard and tough phosphor-bronze, containing but little lead, and the other a much softer alloy, consisting chiefly of lead, with a small proportion of tin and traces of copper. The latter alloy is almost white, and, when the casting is fractured, it will be found nearly equally diffused through it; the phosphor-bronze alloy forming as it were a species of metallic sponge, all of whose cavities are occupied by the soft metal alloy segregated from it. This phenomenon of the segregation into two or more alloys, of combinations of copper with tin and zinc, has long been known, and from the fact that such separation is generally massive, and not equable throughout the mass, it has been a source of great annoyance to the founder. Dr. Kunzel, however, seems to have succeeded in causing the segregation to take place in uniform distribution throughout the casting, and has taken advantage of the properties of the product which he obtains in this manner to construct therefrom bearings of railway and other machinery.

In heavy bearings, such as those for marine engines, the valuable properties of Babbitt metal, and similar anti-friction alloys, are well recognized; but these being generally soft, are open to the grave objection that where they are subjected to considerable pressure, or even moderate pressure accompanied by continued vibration, they become distorted in form, and then fail to sustain the journals in their proper places. The device is, therefore, resorted to by the machinist of casting a hollow cage of hard metal, of proper form, for the intended bearing, the cavities of which he then fills by casting into them the soft metal alloy, which thus forms the actual rubbing surface of the bearing. The hard metal cage supports the soft metal within, and prevents its distortion or escape, save by surface abrasion. Dr. Kunzel claims to effect the same result by the peculiar constitution of his new phosphorized alloy for bearings. This forms its own supporting cage, for the soft bearing metal, which, as alluded to at the outset, separates from it in the progress of cooling. He claims that these bearings combine the very small fric-

tion and non-abrasion of the journals, with the firm resistance to pressure and stability of form of bearings of hard metals. The test of practice alone can decide the value of these claims, though they seem very plausible.—3 *A, October* 24, 1874.

A NEW SILVER-LIKE ALLOY.

A new and inoxidizable alloy, resembling silver, has lately been patented by Le Marquand, of Paris, and has the following composition per kilogramme:

Pure Copper	750	grammes.
Nickel	140	"
Black oxide of Cobalt	20	"
Tin in drops	18	"
Zinc	72	"

These different ingredients are to be melted together in a crucible.—9 *B, May* 6, 208.

PLATING WITH ALUMINIUM.

The following process for covering metal surfaces with aluminium is recommended by J. A. Jeancou: Dissolve any desired quantity of a salt of aluminium, such as sulphate, chloride, nitrate, cyanide, etc., in distilled water, and concentrate the solution to 20° Beaume (at 50° Fahr.) in a vessel suitable for holding the article to be plated. The battery to be used should either be four pairs of Smee's or three of Bunsen's, with the elements connected for intensity, and a plate of aluminium attached to the positive pole. The solution should be slightly acidulated with its appropriate acid, heated to 140° Fahr., and kept at that temperature during the operation.

MANUFACTURE OF STEARIC ACID.

In order to facilitate the removal of the oleic acid in the manufacture of stearic acid, Deisz suggests the addition of 20 per cent. of bisulphide of carbon to the mass before pressing, since but one pressing in the cold will then be required to remove the oleic acid thus diluted, and the bisulphide can easily be removed by distillation. The process is, however, considered objectionable by Professor Heeren, on account of the unavoidable loss of bisulphide, as well as the injurious

action of its vapor upon the operatives. He regards the idea, meantime, as a good one, and thinks the substitution of some less volatile and injurious liquid (as petroleum naphtha) for the bisulphide is well worth trying.—15 *C*, XVII., 1874, 272.

GAUDIN'S POLISHING PAPER.

Messrs. Gaudin & Co., of Paris, have recently introduced a new polishing paper, made with a mixture of silex and alumina melted together and reduced to a fine powder. This they claim is much superior to emery paper or any other substance used for the same purpose. It really constitutes an artificial emery or corundum, but is in a form much more convenient for application than the natural substance.—1 *B*, *May* 2, 61.

PREPARATION OF ABSOLUTE ALCOHOL.

Professor J. L. Smith informs us that alcohol of 98 per cent. can be obtained by shaking up the strongest commercial alcohol with freshly burned lime in a tightly closed vessel, renewing the operation every day for a week or ten days, when the bottles are allowed to remain at rest for a few days for the hydrate of lime to settle, and the original alcohol can be drawn off, free from lime, and of 98 per cent. To obtain absolute alcohol the last draft is to be put into a convenient flask, with the addition of lime in coarse powder and an inverted Liebig condenser attached, so that the alcohol will run back into the flask when condensed. This is then distilled over, and will mark 100 per cent.—1 *A*, *November* 20, 1874, 235.

FILLING HOLLOW BRASS ARTICLES WITH MOLTEN IRON.

Atkins, of Birmingham, casts molten iron in hollow brass objects, without danger of melting them, by simply immersing them in water, which prevents their temperature from rising above 212°. To make weights in this way the brass shell is imbedded in iron filings instead of water.—13 *C*, *November* 1, 1874, 1364.

CEMENT FOR MARBLE AND ALABASTER.

It is said that the point of fracture of articles cemented with the following mixture is difficult to find, and that the

cemented place is much stronger than the material itself: Form a thick paste with water-glass (silicate of soda) by adding as much as may be necessary of a mixture of 12 parts of Portland cement, 6 of slaked lime, 6 of fine sand, and 1 of infusorial earth. The article to be cemented need not be heated. It hardens in twenty-four hours.—18 *C*, *December* 23, 1874, 815.

CEMENT FOR MARBLE WATER-TANKS.

In the Berlin Polytechnic Society, water-glass with marble-dust, glycerine, and litharge was recommended as a cement for water-tanks of marble slabs, with the statement that it was unaffected by hot water. A mixture of 12 parts of cement, 6 of whitening, 6 of fine sand, and 1 of infusorial earth, stirred to a paste with water-glass, was also mentioned for the same purpose.—34 *C*, XXIII., 1874, 183.

RENDERING IRON WIRE OF A SILVERY WHITENESS.

To make iron wire of a silvery whiteness it is first treated in a hydrochloric acid bath in which a piece of zinc is suspended. The corroded wire is then brought in contact with a plate of zinc in a bath in which 2 parts of tartaric acid are dissolved in 100 parts of water, with further addition of 3 parts of tin salt (stannous chloride) and 3 parts of soda.

The wire is allowed to remain some two hours in the bath, and is made bright by polishing or by drawing in the drawing-plate. By this galvanized tinning it is quite easy also to whiten wire which is already rolled up spirally, or iron objects of any other form, which gives an advantage over the mechanical method by which the wire is tinned at a high temperature, and then passed through the drawing-plate.—21 *A*, *July*, 672.

VULCANIZING OF CAOUTCHOUC AT COMMON TEMPERATURES.

The following process devised by Gaulthier de Caulbry is claimed to effect this object. If an intimate mixture is made of flour of sulphur and dry chloride of lime, a decided odor of chloride of sulphur will shortly be noticeable, while simultaneously the temperature of the mixture is appreciably elevated, and the mass becomes plastic by the softening of the sulphur. If a mixture of this kind, in which the sulphur is

in great excess, is added to caoutchouc softened in bisulphide of carbon, it effects the change called vulcanization at ordinary temperature, or upon slight warming. When the mixture contains an excess of the chloride of lime, the mass does not become pasty, but remains pulverulent.—*Scientific American*, XXXII., 374.

CAUSTIC SODA AND POTASH.

Grüneberg & Vorster have patented in England a new process for obtaining the caustic alkalies. The chloride of sodium or of potassium, as the case may be, is mixed with hydrated alumina, and the mixture subjected to the action of superheated steam.—14 *C, February*, 382.

GLASS MANUFACTURED FROM SULPHATE OF SODA, OR CALCINED GLASS.

Dr. Guhrauer calls attention to the fact that, although sulphate of soda can not as yet be employed in the manufacture of a colorless glass suitable for glass vessels, it is extensively used in France, Belgium, and Holland to furnish the alkali in the manufacture of mirror-glass, although it has too decided a tint when even less than an inch in thickness to be used for half-crystal ware, etc. The process by which a glass suitable for the special purpose mentioned is made from sand, lime, sulphate of soda, and charcoal alone, rests upon the previous calcination of the glass mass, or the preparation of what may be called a finely divided, calcined glass; this is accomplished by allowing the barely fused mass to flow suddenly into cold water. After thoroughly drying this it is again fused, with the addition of broken glass, decolorizing and purifying material, as binoxide of manganese, nitre, etc.; but the desired degree of freedom from color depends in a great measure on the careful selection of the raw material, and the proportions in which the ingredients are mixed. Any furnace, upon any system of heating, will answer, and the glass, when in a very viscid condition, may be simply run off through openings, closed by valves through which water circulates, into tanks filled with water, from which it is then taken and dried, and re-fused. The consumption of time and fuel, by reason of the double fusion required, is not necessarily much, if indeed

any, greater, while there are the advantages of cheapness of material in the sulphate of soda and of quality in the glass, since it may contain much less alkali. The number of furnaces need not necessarily be increased, as the same furnace may be used for the different operations. — 14 *C*, CCXV., 1875, 358.

THE MICROSCOPIC STUDY OF FIBRES USED IN THE FABRICATION OF PAPER.

The study of vegetable fibres has already occupied many observers; and the classical memoirs of Aleau and Vetillart are well known. These researches have generally had for their object the application of vegetable fibres to the textile arts; their application to the manufacture of paper has been less fully considered, but forms the subject of an extensive work recently published by Gérard, who has especially studied those vegetable fibres that enter into the composition of the pulp of the paper manufactures. He has determined with the microscope the form, dimensions, and special characters of these fibres, and, in order to illustrate his results, has reproduced the microscopic appearances by means of photography. He states the conditions which must be fulfilled by the fibre that is to produce good paper as follows: First, with reference to the length of the fibre, he finds that the pulp styled "short refined" is composed of fibres of from 0.3 to 0.5 of a millimeter in length, while if it is from one to one and a half millimeters long, it is "long refined." Rarely does it surpass this latter length; and as there is no vegetable fibre that he has examined which is not at least equal to this latter length, he concludes that they are all, so far as that is concerned, proper for the manufacture of paper. Second, it is an important consideration that the fibre should be fine as well as long—in other words, the ratio of its length to its diameter should be at least fifty to one. Third, the fibre should be elastic, and submit to twisting with ease. It is this that gives solidity to the sheet. On the other hand, the tenacity of the fibre is a matter of only secondary importance; as is seen if we notice that when a sheet of paper is torn the fibres themselves are never torn, but simply slide over and separate from their neighbors. According to their relative value in the manufacture of paper, he classifies the fibres as follows:

First, round fibres that can lend themselves easily to the formation of twisted cords. Those of hemp and flax are the only ones of this class. Second, round smooth fibres that do not easily form cording, such as jute, feather-grass, palm, sugar-cane, etc. Third, the materials of cellular fibrous nature, of which the only one worthy of note is the pulp obtained from the straw of rye or wheat under the action of caustic solutions. Fourth, fibrous plates, under which head he classes fibres of cotton and those extracted from wood by chemical processes, those of the agave, bamboo, etc. Fifth, imperfect material, such as the pulp obtained by the mechanical maceration of wood.—*Bulletin Hebdom.*, XVI., 69.

PREPARATION OF ARTIFICIAL CAOUTCHOUC.

A mass, said to resemble caoutchouc, and soluble in linseed oil, may be prepared by heating in an iron kettle, which should only be half filled, ten pounds of sulphur, or flowers of sulphur, and twenty pounds of rape-seed oil, with constant stirring, until the sulphur is melted and the mass begins to swell; then immediately pouring it into a mould, dusted with some kind of powder, or upon a stone slab moistened with water, when it will harden at once. Linseed oil may replace the rape-seed oil, in which case less sulphur must be taken.

USE OF THE WILD RICE PLANT IN PAPER-MAKING.

The stem of the American wild rice, *Zizania aquatica*, is now coming extensively into use as a material for paper pulp, yielding, as it does, fully as much of the raw material as the esparto, and being comparatively free from silicates. The paper made from this substance is quite as strong and as flexible as that from rags, while it is easily bleached, economical in respect to chemicals, pure in color, and remarkably free from specks and blemishes. It is estimated that one hundred thousand tons can easily be obtained from the shores of the Canadian lakes alone.—12 *A*, *September* 24, 1874, 427.

VALUE OF THE MILK-WEED AS A FIBRE-PLANT.

M. Roux calls attention to the value of the common milkweed (*Asclepias Syriaca*), so abundant along roadsides in

the United States, as furnishing an important fibre, possessing numerous points of superiority over the common hemp, especially in view of the fact that it accommodates itself to more barren regions and requires no culture. Being hermaphrodite, and not diœcious, it produces on a given area a greater number of plants, and therefore the amount of textile fibre is much greater. It begins to grow toward the end of April, and flowers in July. It succeeds especially well in dry seasons. The height of its stalks is about five feet, and its pulp furnishes a most excellent material for paper.—1 *F*, *October* 15, 1874, 164.

PREPARATION OF WOOD-PASTE FOR PLATES, ETC.

The mass obtained by the following process, though brittle at first, acquires a surprising degree of firmness after gradual drying in the air, and the separate particles of wood may be firmly united and hardened by moistening three or four times, as soon as it is firm enough, with about a 5 per cent. solution of potash, and then drying it thoroughly. By substituting bichromate of potash for the potash, it may also be rendered water-proof as well as hard, and by adding different dye-stuffs, or the crude dye-woods, to the alum mordant, colored wooden plates and objects may be produced. One hundred parts of sawdust (best of soft wood) are boiled for half an hour in a concentrated solution of 100 parts of sulphate of alumina, in water, and then allowed to cool. Fifty parts of glue, dissolved in 100 parts of boiling water, are then intimately mixed with the above mass, and the whole thoroughly kneaded and subjected to a very high pressure.—34 *C*, XX., 1874, 159.

PREPARATION OF EBONITE.

The use of ebonite, one of the newer preparations of India rubber, is constantly increasing, on account of its better applicability to many purposes in the arts than its near ally, vulcanite. The two substances are quite similar, being composed of India rubber and sulphur, with some preparation of gutta-percha, shellac, asphalt, graphite, etc.; although these latter are not essential. In vulcanite, the amount of sulphur does not exceed 20 to 30 per cent., whereas in ebonite the percentage of sulphur may reach as high as 60. An in-

creased temperature is also required for this preparation. The approved formula consists in mixing together 100 parts of rubber, 45 of sulphur, and 10 of gutta-percha, with sufficient heat to facilitate the combination. In manufacture, a sufficient quantity of this mixture is placed in a mould of a desired shape, and of such material as will not be affected by the sulphur contained in the mass. It is then exposed to heat of about 315°, and a pressure of about 12 pounds to the square inch, for two hours. This is done most readily by placing the mould in a steam-pan, where the requisite pressure and temperature can easily be kept up. When cold, the ebonite is removed from the mould, finished, and polished in the usual manner.—18 *A*, *January* 8, 1875, 818.

GLAZING PAPER BY PARAFFIN.

According to Dr. Vohl, the following process for glazing paper by means of paraffin is adapted to white and all delicate tints: Add 100 parts, by weight, of fine, washed, and dried pure white China clay, previously heated to at least the temperature of fusion of paraffin, to 24 parts of (easily fusible) melted paraffin. The clay, if hot enough, will completely absorb the liquid paraffin. Pulverize the mass, when cold, and grind in the color-mill with cold water. Add from 4 to 6 per cent. of this semi-fluid mass to the color previously prepared, and treat the dried paper as usual. The driest and dullest earth colors assume a fine glaze by this process; and for dark tints clays with a decided color may be used. The paraffin mixture may also be employed with advantage for glazed pasteboard, as it likewise renders it less liable to be affected by moisture.—6 *C*, *July* 16, 1874, 265.

POLISHING-CLOTH FOR BRASS.

A sort of linen was exhibited at the Vienna Exposition which served the purpose of cleaning and polishing brass very well, and was at the same time cheap enough for general use. Investigations by Dr. Reichardt indicate that the effect is due to the presence of silicic acid and an alkali, and that the article may be prepared by impregnating some loose fabric, such as fustian, with a weak solution of water-glass, and then washing it thoroughly. A not inconsiderable

amount of silicic acid will be retained, in a manner analogous to alumina in dyeing.—14 *C*, CCXIII., 528.

SOLDERING PLATINIZED GLASS SURFACES TO METALS.

It has been found by Dr. Rönzgen that glass can be more firmly affixed to metals by coating it with platinum, and soldering, than it can be by cement. The tinning of the platinum surface is very easily effected by means of a soldering iron and chloride of zinc. The excess of platinum coating may be wiped off with filter-paper dipped in dilute hydrofluoric acid. The glass, of course, should be carefully warmed before applying the soldering-iron. The platinum coating is said to adhere to the glass so firmly that a well-soldered piece of metal can not be removed without injuring the surface of the glass.—5 *C*, XXXIII., 1874, 264.

IMPROVED MODE OF CLOSING BARREL HOOPS.

It is claimed that the ends of hoops on barrels may be securely joined with great economy of time and labor on the following plan, devised by Cattin: A small plate of sheet-metal has two slits punched in it in such a way that the hoops may be drawn through them readily in one direction, and are prevented from slipping out by the sharp edges of the plate cutting into them. The surface is rendered smooth by a blow with a hammer on the projecting ends of the hoops.—9 *C*, *July*, 1874, 105.

UTILIZATION OF LEATHER WASTE.

While numerous processes for utilizing the offal in the manufacture of leather are in successful operation, there has been a comparatively open field respecting leather waste. At the Vienna Exhibition, leather was shown suitable for heels, toe-caps, and inner soles, prepared from leather clippings, according to a French method, by simply mixing them with some adhesive substance, forming the mass into rectangular plates on top of each other, subjecting them to hydraulic pressure, and then drying and rolling them. This article was restricted in use because it could not withstand moisture. A Copenhagen firm, however, exhibited, for the first time, an article made upon an entirely different plan. The leather scraps were first converted, in a suitable ma-

chine, into a sort of leather-wool, which was then mixed with caoutchouc and different chemical reagents, kneaded by machinery into a thick pasty mass, and formed in metal moulds, dried, and subjected to a gradually increasing pressure until it was finished, under 6000 to 10,000 pounds to the square inch. The appearance of leather is imparted to it by a light coating. Articles manufactured from this material are said to be 50 per cent. cheaper than those from leather, and can be made in the same manner, while they are also perfectly water-proof. Chemical investigation shows it to consist of about 40 per cent. caoutchouc and 60 per cent. leather.—14 *C*, CCXXIII., 1874, 81.

MANUFACTURE OF COPPER AND BRASS WIRE.

In order to produce very long strips of brass or copper, to be drawn into wire, Lavéissière & Son, of Paris, have devised a plan of cutting them from circular plates in spiral form by means of circular shears.—14 *C*, CCXV., 1875, 377.

NEW TREATMENT OF HIDES IN TANNING.

The following preliminary treatment of hides, patented by Sainte-Marie, is said to materially shorten the time required for tanning, and in the one case to afford a soft, pliable material, and in the other to render the hides more suitable for the reception of dyes. The hides, after being freed from hair and flesh by caustic alkalies, are immersed in an aqueous solution of sulphate of ammonia, 6 to 11 pounds to from 800 to 1000 quarts of water, or in a solution of 11 pounds of sulphate of ammonia, and 22 pounds of sulphate of soda, in 800 to 1000 quarts of water.—15 *C*, XVIII., 1874, 288.

CUTTING AND BORING CAOUTCHOUC CORKS.

By moistening the knife or borer with a moderately strong solution of caustic soda and potash, instead of water or alcohol, it is said that India rubber may be cut with as much ease as ordinary cork-wood.—9 *C*, *July*, 1874, 106.

A WRITING-MACHINE.

It is said that in Austria there exists an official Bureau of Stenography, and that a uniformity in stenographic writing is imposed upon all the profession. Usually the writing of

one stenographer is intelligible only to himself. The idea of creating a universal language for stenography, independent of the caprice of the operators, is claimed for various persons. As long ago as 1845, Gensoul, of France, occupied himself with this problem, a solution of which was indispensable to the success of the stenographic principles of which he is the inventor. Stenographic laws have received numerous improvements during these thirty years, both by Gensoul and by his son, who continues to develop the work of his father; and the instrument referred to, as at present constructed, is a manageable piece of apparatus, very convenient and not excessively costly. Many public experiments have been made with it at various times. Entire volumes of discussions and conferences have been published, and the Gensoul machines are at present regularly manufactured. This apparatus, which allows of writing 200 or 250 words per minute (the number of syllables falling from the lips of the most voluble orator), may be described as a piano-forte, upon which there appear twelve white and twelve black keys, which may be moved with the fingers, and two supplementary keys are added, one on the right and one on the left, that are operated by the wrists. Each key produces its indications in marks, on a roll of paper, similar to that which flows in the Morse apparatus. The only difference is that the black keys give long marks, while the white keys make only points. Every time that the keys are touched the paper is automatically unrolled to the extent of one fiftieth of an inch, so that one can make, on every line of the paper, any combination whatever of twelve double signals. These signals are arranged by three groups of four each; the three groups being read from left to right, like ordinary writing. The number of signals that can be made upon each line is more than sufficient for giving a letter for every movement of the paper; and, with skill, three letters at least may be written at once. If we suppress the useless letters, such as mutes, double letters, etc., it is rare that each movement of the paper does not give a complete word. If a word has to be continued to the following line, a mark is made by a movement of the wrist keys. The manipulation of the machine demands considerable skill, for, although one can learn to read the writing in half an hour, it is necessary to have five or six months'

experience in order to follow a speaker. But one good operator will amply suffice to report legislative debates, word by word, during the most complicated sittings. If two good operators be placed, with their machines separated from each other by a considerable distance, a complete control upon the exactness of the record of the debate is insured. The reading of the written band is so easy that it is given over to the printer without inconvenience, or to clerks practiced in autographic writing. The bands of paper have not so great a length as may be imagined: a sitting of one hour consuming about seventy feet of a roll whose width is four inches.—13 *B*, III., 211.

THE JAPANESE LEATHER-PAPER.

The curious leather-paper made by the Japanese, which imitates in a remarkable degree the leather of Cordova, excited much attention at the late Exposition at Vienna; but the method of its fabrication has, until lately, remained a secret in that country, whence many objects made of it have been imported, such as napkins, clothing, umbrellas, lanterns, etc., all of which have much strength and firmness. Mons. Zeppa, a member of the Oriental Society of Japan, has lately published the processes by means of which this paper is produced. The material employed is bark of the *Broussonetia papyrifera*, or the paper-mulberry. It is the same substance that the Polynesians make use of in the manufacture of certain vestments, and even for the masts of their boats, although their process of fabrication is entirely different from that of the Japanese. The cultivation of the mulberry is very simple; the roots being placed in the earth, spread and grow rapidly, attaining a length of nine inches the first year, and twenty-seven in the second. At the end of three years the plant has a height of about thirteen feet. On the approach of fall and winter the branches are removed, and cut into pieces two inches long. These are then boiled until the bark can be easily taken off with the hand. The bark is first dried in the air for two or three days, then plunged over twenty-four hours into a current of fresh water, after which, with the aid of a particular kind of cord, the two species of fibres of which it is composed can be separated. The exterior fibres are of a dark color, and are called *sara kawa*. They are employed

in making paper of an inferior quality. The interior fibres have the name of *so sori*, with which the fine paper is made. These are rolled into balls weighing about thirty-five pounds each, which are washed anew in running water, in which they are allowed to soak for a shorter time than on the previous occasion, after which they are dried. Finally they are boiled in lye made from the ashes of buckwheat flour, taking care that the contents of the tubs are always kept in motion. Another washing in pure water carries away the last impurities, and the fibres are then pounded with hammers of wood for about twenty minutes. After this they are a second time rolled into balls, and finally transformed into pulp. The pulp being once obtained, rice-water is mixed with it, and a small quantity of a liquid extract from the root of the *Hibiscus manihot*, to preserve it from the attacks of insects. The subsequent treatment of the pulp is identical with that of the ordinary manufacture of paper. The leather-paper is finally obtained by the superposition of many sheets of the material, it being previously steeped a moment in an oily extract from yonoko submitted to a strong pressure, and covered with a glazing called *shellas*. Garments are made from a variety of this paper, designated under the name of *She fu*, which is drawn out into finer or coarser threads according to the quality of the tissue that is to be made. These threads are twisted between the fingers wet with lime-water, and are finally either woven singly or mixed with silk. —13 *B*, III., 322.

NEW COLORS OF CROISSANT & BRETONNIÈRE.

Great interest continues to be excited by the remarkable character of the new colors invented by Messrs. Croissant & Bretonnière, on account of their wonderful cheapness and admirable qualities. They include nearly all the tints known to the dyers (excepting red, blue, and green), with their modifications. The cost is so trifling that a hundred-weight of the dye, which will prove a substitute for logwood, costs only about seven dollars, while an equivalent amount of extract of logwood costs as many pounds sterling. In permanence, the new colors greatly outstrip those now in use. They are not affected by light, oxalate of potash, nor even by hot soda; in fact, by nothing but concentrated chlorine.

Used with other colors, they render the latter more permanent, especially alkaline preparations. The varieties of shade are not produced by mixtures, but by regulating the temperature to which the color is exposed in the course of manufacture. These colors attach themselves permanently to the fibres, by the mere evaporation of the water in which they are dissolved. They are all soluble in water, and are precipitated by mineral as well as by organic acids. They dye equally well silk, cotton, and linen.

The method of dyeing is as follows: The colors are dissolved in hot water, and the goods are steeped and turned in the solution from thirty to forty-five minutes; they are next fixed by a hot solution of bichromate of potash, in which they are left for about fifteen minutes, washed with pure water (in the case of wool and silk, to remove excess of alkali), and then placed in an alkaline bath made up with a pound of soda to forty-seven quarts of water, and washed finally with clear water.—1 *A*, *October* 16, 1874, 180.

TESTS FOR THE PRINCIPAL DYE-STUFFS IN COLORED FABRICS.

The following course of examination has been suggested by F. Fohl for ascertaining the dye-stuff employed in any particular case in producing one of the five principal colors.

I. Blue.—Logwood, Prussian-blue, aniline-blue, and indigo are chiefly to be considered. Proceed as follows:

A. Cover a sample of the fabric, the color of which is to be tested, with citric, or dilute hydrochloric, acid: 1. Change of color to red or orange indicates logwood; 2. No change of color—either Prussian-blue, aniline-blue, or indigo. B. Immerse another sample in a solution of chloride of lime: 1. No change of color—Prussian-blue; 2. Decoloration, or a yellowish coloration—aniline-blue or indigo-blue; to distinguish between these two, place another sample in caustic soda, when decoloration, or change of color, will indicate aniline-blue, and permanence of color indigo-blue. The presence of the blue dye, indicated by the preceding tests, may be confirmed by the following reactions. *Logwood-blue* is reddened by acids, and restored by alkalies. The fabric yields a white or grayish ash on incineration—of the former color if the mordant was alum, of the latter if it was blue vitriol; and in this latter case the edge of the flame, during incineration, will also have

a greenish tinge. *Prussian-blue*—on incineration the fabric leaves a residue of ferric oxide, proportioned in amount to the intensity of the color. *Indigo-blue* leaves no ash, except that of the fabric itself, which is white and light. *Aniline-blue*, like indigo-blue, leaves no ash but that of the fabric; but it is easily distinguished from it, since the color can be extracted from the fabric by alcohol, and it is distinguished from logwood by means of citric acid, which does not redden it.

II. Yellow.—Rust-yellow, picric acid, turmeric, fustic, Persian-berries, and quercitron are the most preferable yellows. A. In order to recognize the different colors, the presence or absence of rust-yellow and picric acid must first be determined. 1. Immerse a sample in warm, slightly acid solution of yellow prussiate of potash—rust-color will be indicated by a blue coloration; 2. Immerse another sample in a solution of cyanide of potassium, picric acid will yield a blood-red coloration. B. If picric acid and rust-yellow are both absent, place another sample in a boiling solution of one part of soap and 200 of water: 1. It turns reddish-brown and becomes yellow again with an acid—turmeric; 2. It turns quite dark—fustic; 3. It is unaffected—weld, Persian-berries, or quercitron. To distinguish between these three: boil a fresh sample briskly in sulphuric acid, color of weld will disappear, of the others remains; then boil a fresh sample in a tin-salt solution, when a change of orange indicates Persian-berries, and no change, or a very slight one, quercitron. C. Annatto, if it happen to be the dye-stuff, may be detected by the greenish-blue color imparted to a sample of the fabric dipped in concentrated sulphuric acid, it being the only yellow that gives this reaction, and it is also unaffected by chlorine, which decolorizes the yellow of quercitron, turmeric, Persian-berries, and weld.

III. Red.—Cochineal, Brazil-wood, madder, saffron-carmine, and aniline-red are to be considered. A. Dip four separate samples of the fabric into boiling soap-solution, ammonia, lemon-juice, and a mixture of equal parts of tin-salt, hydrochloric acid, and water: 1. No change in any of the samples indicates madder; 2. Any change indicates the absence of madder, and the presence of one of the other four reds: *a*, thus complete decoloration by the soap-solution, especially if the color does not return, with its peculiar shade, after the fabric

has been washed with water, and agitated with lemon-juice, indicates saffron-carmine; *b*, reappearance of the red color, though weaker, by this treatment—aniline-red; *c*, production of a yellowish red, or light yellow color by this treatment—cochineal, or Brazil-wood, to be distinguished from each other by dipping a fresh sample in concentrated sulphuric acid, when Brazil-wood will at once give a beautiful cherry-red color, and cochineal a yellowish-orange.

IV. Green.—Dyers distinguish three kinds of green: viz., those by mixture of blue and yellow, aniline-green from aldehyde, and new aniline-green from methyl-iodide. The greens by mixture of blue and yellow, although passing into disuse, may be met with. The principal ones are: indigo with picric acid, indigo with vegetable yellows, Prussian-blue with picric acid, Prussian-blue with vegetable yellows, aniline with picric acid, and aniline-blue with vegetable yellows. The blues form the foundation of these greens, and as a rule are insoluble in alcohol, except aniline-blue, while all the yellows mentioned are soluble in alcohol, so that the acquisition of a green color by the alcohol, with which a sample dyed with a mixed green is treated, indicates at once a mixture of aniline-blue and a yellow, if by a previous test the absence of aniline-green was determined. The following course serves to determine the nature of the green dye-stuff: Heat a sample of the fabric on a water-bath for a few minutes in 95 per cent. alcohol. The alcohol either becomes, 1, yellow, while the fabric becomes more and more blue; or, 2, green, while the fabric retains its color, though with diminished intensity. In the first case Prussian-blue or indigo may be present; therefore extract the fabric thoroughly with alcohol, then wash it well with pure water, and cover it with a solution of chloride of lime, whereby indigo-blue will be decolorized, but Prussian-blue will remain unchanged. The yellow may be determined in the alcoholic solution by the method previously given. In the second case aniline-green from aldehyde, aniline-green from methyl-iodide, or aniline-blue mixed with a yellow, must be considered. To distinguish between them, boil a sample of the fabric in weak hydrochloric acid, whereby decoloration, or change to yellowish, indicates the first of the three; change to rose or lilac, the second; and change to blue, while the yellow dissolves,

the third; and the yellow in solution can be determined by methods already given.

V. VIOLET.—Common aniline-violet, aniline-violet from iodine, madder-violet, alkanet-violet, orchil-violet, logwood-violet, and cochineal-violet are chiefly to be considered. A. Immerse a sample in a solution of chloride of lime. 1. No change of color indicates alkanet. 2. Any change one of the other six. B. Immerse another sample in lemon-juice. 1. The violet becomes brighter by presence of one of the aniline violets, to be distinguished from each other by dipping a sample in hydrochloric acid diluted with three times its volume of water, when it will become violet-blue, and after washing somewhat redder, if it is common aniline-violet; but blue, greenish, and after washing light lilac or pearl gray, if it is aniline-violet from iodine (Hoffmann, "New Parma, Primula," etc.). 2. The sample becomes red, or even yellow, in the lemon-juice. Test for the other four violets: *a.* Place a sample, after washing it on removal from a solution of chloride of lime, in a solution of yellow prussiate of potash, whereby a blue coloration (Prussian-blue), formed with the iron mordant in the fabric, employed with madder and cochineal, indicates the presence of one of them; distinguishable from each other by the fact that, if the former, the sample turns nankeen-yellow in the chloride of lime solution, and, if the latter, it is completely decolorized. *b.* Absence of the preceding blue coloration leaves orchil and logwood to be considered. To distinguish between them, immerse a sample in milk of lime, whereby a change to gray, and final, almost complete decoloration, indicates logwood; and a change to violet-blue, orchil. The preceding can also be classified by their ash: thus if it contains iron, madder and cochineal are indicated; if it is white, orchil and logwood; while the aniline violets afford no ash of their own. The testing of the ash is indeed very important, since the determination of the mordant employed—iron, alum, chromium—may point directly to the accompanying dye-stuff.—5 *C*, XXVII., 1874, 212.

UNIVERSAL GAS-LAMP FOR LABORATORIES.

This lamp, as described by Müncke, permits the diminution of the flame to any extent without rendering it liable to strike down, and it can also be made to afford a reducing

flame. The flow of gas and admission of the air are both regulated by collars at the end of a horizontal handle, so that the tip of the jet is not liable to injury by liquids, etc., accidentally falling into the lamp; it is, besides, also supplied with a curved attachment for the end of the lamp tube, with which it is impossible for fused substances to run into the lamp. By a flat attachment a broad, narrow flame is afforded, suitable for heating uniformly a considerable length of a glass tube, as in bending it, and by rose and gauze-burner attachments, any desired distribution of the flame can be made; while a tripod, adapted to the support of capsules, flasks, etc., which can be attached to the cast-iron foot of the lamp, and be moved with it, completes its character as a perfect gas-stove.—5 *C*, XXIX., 1874, 231.

DE LA BASTIE'S HARD OR TEMPERED GLASS.

A French engineer, M. François de la Bastie, after a long series of experiments, has discovered a simple means of rendering glass practically unbrittle, and at the same time of preserving its transparency, which it is understood he intends to utilize by commencing the manufacture of articles of toughened glass upon an extensive scale. The process of conversion is, in the main, a very simple one. In general terms, it consists in heating the glass to a certain temperature, and plunging it, while yet hot, in a heated bath of some oleaginous compound. There are, it is represented, many conditions and details upon which the success of the operation depends. Of these, the temperature of the glass and the nature and temperature of the oil-bath are named as the most important. These and other matters of detail, report says, M. De la Bastie has satisfactorily solved, and has constructed furnaces and apparatus with which his tempering process can be carried into effect without risk or failure. The time actually employed in the tempering is but nominal, the articles, heated to the required temperature, being simply inserted into the bath and instantly withdrawn. The cost of the operation is likewise represented to be small.

M. De la Bastie's experiments, it is said, were first made with the object of effecting the toughening of glass by compression, but without success; for although this principle holds good in practice with the metals, and especially with

iron and steel, it appears not to apply to glass. By the application of heat in the form of a tempering bath, however, he succeeded in effecting his purpose, and in changing the physical properties of this material to a remarkable degree.

That the invention is attracting considerable notice will be manifest from the following comments of the London *Times* of recent issue: "Of the practical value of M. De la Bastie's discovery there can be no question whatever; nor can there be any doubt of its value in the arts, sciences, and manufactures. The applications which suggest themselves are innumerable; and above and beyond the utility of the process in relation to articles of domestic use, come important considerations affecting the applied sciences, especially in connection with chemical manufactures and similar industries, where a material equally indifferent to the action of heat and acids has been long and vainly sought for—notably in connection with the vitriol chambers in the manufacture of sulphuric acid, and for piping in chemical works."

The technical journals give at considerable length the details of a number of comparative tests of the strength of the Bastie product and of ordinary glass, which appear to be well authenticated. These accounts all agree in the statement that the tempered glass possesses, in comparison with the ordinary glass, an astonishing degree of toughness, whether subjected to the test of rapid alternations of heat and cold or the impact of a falling weight. The following comparative experiment, selected from a number, will serve our purpose. A piece of ordinary plate-glass is reported to have been broken by a 2-ounce brass weight falling from a height of 24 inches. On a thinner piece of toughened glass no impression was made by the same weight falling from heights ranging from 2 feet to 10 feet, the weight simply rebounding from the glass. An 8-ounce weight, tried at 2 feet and 4 feet, gave with the same piece a similar result. At 6 feet, however, the glass broke. The breaking of the plates under these circumstances appears to be attended with the same phenomenon of complete disintegration that characterizes the well-known scientific toy known as Prince Rupert's drop—a coincidence that may be of value in explaining the nature of the change of qualities effected by the Bastie process.

DE LA BASTIE'S EXPERIMENTS IN TEMPERING GLASS.

De la Bastie, the inventor of the process for the tempering of glass, whereby its strength is increased and its brittleness removed, states that all liquids are not suitable for the purpose; that it is necessary by experiment upon each of them to determine those which insure the success of the operation, and among these even a choice will still have to be made. Some in fact double, others quadruple, and others even tenfold increase the solidity of the glass. The maximum strength possible has been determined by Siemens, of Dresden, to be about fifty times that of ordinary glass. Bastie has himself determined for every liquid the co-efficient of its strengthening power. Three elements concur in the determination of this co-efficient: First, the composition of the bath, which is never formed of a single liquid. Secondly, the proportion in which each material enters into its composition; and, finally, its temperature. This last element is not that which has demanded the least amount of study. At one degree of temperature the glass becomes brittle, instead of being tempered. At another temperature it acquires solidity, and at still another it may attain its maximum of solidity. There are also other considerations. The proper temperature of the bath will vary according to the chemical constitution of the glass, and according to the oxides which enter into its fabrication: the different temperatures needed for either of two different glasses may vary to the extent of 200° Centigrade. If one calculates all the combinations which have to be made, in order to determine by purely empirical means the most favorable conditions to success, taking account of the various elements, the composition of the bath, the preparation of the various liquids which compose it, the thermometric state, the chemical constitution of the various glasses, etc., we shall not be astonished that this study has demanded many years of work, which was not always without danger. As to the value of his discovery, from an economical and industrial point of view, De la Bastie states that his researches have not been conducted as an object of mere curiosity. His invention leaves his hand complete in every respect, so that he is ready to manufacture strong and malleable glasses of every kind, for every purpose to which such material can be applied.

It may even replace iron and lead in the construction of gas and water pipes.—*Bulletin Hebdomadaire*, XVI., 22.

EXPLANATION OF SO-CALLED HARDENED GLASS.

No adequate explanation of the hardening of glass by the new method of annealing seems as yet to have been given. Professor Bauer, who has successfully imitated the glass produced by the French method, suggests the following. The glass at once calls to mind the phenomenon of Rupert's drop; but the latter can not be accounted for satisfactorily, since it has been shown that if the point is dissolved off by fluohydric acid, instead of pinched off, the whole drop does not burst. On the other hand, the hardened glass also recalls the fact that, although glass in a state of fusion may be considered as homogeneous, yet upon cooling it does not form a perfectly homogeneous and amorphous mass, as was formerly supposed; but that all varieties, even those that are apparently without a trace of crystallization, are mixtures of crystalline and amorphous particles, as manifested under the action of fluohydric acid. This want of homogeneity in the structure of glass, which is produced to a certain depth by slow cooling, is evidently prevented by rapid cooling. Therefore by cooling fused, or even softened glass very slowly, it may easily happen that this separation into crystalline and amorphous particles may take place. The preparation of so-called Réaumur's porcelain depends on this fact; and quite recent experiments show that the crystalline portions may even become visible, and the glass is said to be devitrified. An explanation of the hardness and peculiar fracture of the hardened glass may be connected with these facts.—14 *C*, CCXV., 1875, 382.

PHOTOSTEREOTYPY.

A sheet of ordinary plate glass larger than the picture to be reproduced is coated in the dark room with a solution made by dissolving 1 ounce of potassium bichromate in 15 ounces of water, warming gradually, then adding 2 ounces of fine gelatin and filtering through linen at the boiling heat. A diapositive is taken from an ordinary negative, and laid with the collodion side to the gelatin face of the prepared plate in diffused light for 10 to 30 minutes. The

plate is then taken from the frame in the dark room and washed with water for five or ten minutes, till the relief is fully developed, after which it is dried with filtered paper and coated with glycerine by means of a camel's-hair pencil, and the excess of liquid is removed with filter-paper. From this plate a cast is made in plaster of Paris of the consistency of oil, and from the plaster cast a metal one may be taken.—21 *A*, *Sept.*, 1874, 930.

PHOSPHOR-BRONZE.

M. Delatot, in an article upon "phosphor-bronze," states that it is not an alloy, but a true chemical combination of copper with phosphorus, or a phosphide of copper in definite proportions. The union of the two may be through the cold or the hot process, the cold sufficing for certain applications, being preferable indeed to combinations produced by heat. By the hot process the introduction of simple bodies other than the metals or metalloids is prevented. The copper used in the process must be commercially pure. Of the three kinds of phosphorus the operator may take his choice: the ordinary, the amorphous, and the earthy biphosphates. The amorphous is the most expensive, and is also the best. According to Delatot, the percentage of phosphorus varies from 2 to 4, between which there may be an infinity of degrees, although for industrial purposes five varieties meet all the requirements. These are formed with 2 per cent. of phosphorus, 2½ per cent., 3, 3½, and 4 per cent. Above 4 phosphor-bronze is useless, but between 3 and 4 per cent. the material is claimed to be superior to any other metal or alloy. The price of phosphor-bronze, unworked, should not exceed that of copper plus 10 per cent.—18 *A*, *April* 9, 1875, 97.

N. MATERIA MEDICA, THERAPEUTICS, AND HYGIENE.

THE POISONOUS PROPERTIES OF ALCOHOLS.

Dujardin-Beaumetz and Andigé have made some curious toxicological experiments with the fermentation alcohols of ethyl, propyl, butyl, and amyl. Over sixty dogs were subjected to investigation, and each poison was tested not only through the stomach, but also by administration through the skin. The intensity of the poisoning is greatest when the alcohol is taken into the stomach, and seems, if we arrange the four substances above named in a series, to increase in a serial way. Thus ethyl alcohol (common alcohol), having the lowest molecular weight, is the least poisonous, while amyl alcohol (fusel-oil), at the other end of the list, is the most so.—6 *B*, *July* 26.

A NEW SEDATIVE.

M. Bonneville has investigated the therapeutic properties of monobrominated camphor, and finds it to be a decided sedative. Tested upon small animals, like rabbits and cats, he found it to depress the action of the heart, to diminish the number of respirations without disturbing their rhythm, and to lower the bodily temperature very regularly, in a remarkable degree. Tested upon human beings, it gave satisfactory results in cases of chorea, hysteria, cardiac affections of nervous origin, and epilepsy. The new remedy was dissolved, sometimes in alcohol, sometimes in glycerine, but the dose is not stated.—6 *B*, *August* 9.

DETECTION OF ARSENIC IN TISSUES.

The problem of detecting arsenic in medico-legal cases is often rendered obscure by the liability the chemist incurs of losing a large part of the poison. Gautier now proposes a method by which almost every trace of the arsenic contained in a quantity of muscle, or other animal matter, can be recovered and estimated quantitatively. The finely chopped muscle, liver, or brain, as the case may be, is treat-

ed in a large capsule, first with one third its weight of nitric acid, and warmed. When the mass becomes viscous the heat is withdrawn, and a few grammes of strong sulphuric acid added. Then, after warming again until white vapors begin to come off, half the original quantity of nitric acid is poured in, drop by drop. The mass is now to be heated until it begins to carbonize, and a black residue is obtained which can be easily lixiviated by boiling water. To the hot, filtered solution sodium bisulphite is to be added, until sulphurous acid is given off, and then the arsenic may be precipitated in the usual manner by sulphureted hydrogen. In a test experiment 0.005 gramme of white arsenic was mixed with 100 grammes of beef muscle. This should contain 0.00378 gramme of the metal, and 0.00365 was actually recovered.—6 *B*, *August* 2.

DETECTION OF FUSEL-OIL IN ALCOHOL.

According to Bettelli, in order to detect fusel-oil in alcohol it is only necessary to shake the suspected sample, diluted by six or seven times its volume of water, with fifteen to twenty drops of chloroform. The latter takes up any fusel-oil which may be present, leaving it behind after evaporation, to be recognized by its odor. By this method a fraction of one per cent. of fusel-oil is easily detected.—*Bull. Soc. Chimique, July* 20, 1875.

GROUNDWORT AS A FEBRIFUGE.

Glocener, of Hainault, announces that he has discovered in the groundwort (*Senecio arvensis*) virtues as a febrifuge superior to those of cinchona and its derivatives. Fifty grammes of the fresh plant, exclusive of the root, are to be boiled for ten minutes in 500 grammes of water, and the solution strained. This is to be taken in three doses, at intervals of two hours, after the attack. In nearly every case positive relief, if not a cure, is claimed as the result.—1 *B*, *January* 10, 1875, 240.

EFFECT OF MORPHIA ON SECRETIONS.

From a paper by Kratschmer upon the influence of morphia, and of carbonate and sulphate of soda on the formation of sugar, and the excretion of urea in diabetes, it appears

that in morphia we actually possess a remedy that not only very materially reduces the excretion of sugar in this disease, but decidedly diminishes the metamorphosis of tissue in the body generally. In this respect morphia resembles alcohol and tobacco, and appears to form a valuable means of making up for an imperfect supply of food, provided its secondary influences are not in the way.—13 *A*, *March* 21, 1874, 319.

THERAPEUTICAL USES OF HOT BATHS.

Professor Lasègue, in a paper on the therapeutical uses of hot baths, remarks that these should be of short duration—from twenty to thirty minutes at furthest—the temperature on entering the bath to be lower than that on quitting it, whatever extremes it may reach in the mean time, and the increase of temperature always to be made gradually. The maximum should be 118° Fahr., although 113° is perhaps a better limit. This temperature is easily borne, provided the escaping steam be not felt on the uncovered portions of the body, and also provided that the maximum be not maintained over eight or ten minutes. On leaving the bath the patient is to be placed in his bed, where he soon regains, not his true temperature, which has varied but little, but his apparent temperature. M. Lasègue finds that cold applications immediately after the hot bath, contrary to what takes place after vapor baths, are neither useful nor agreeable. The disease which yields most readily to this system of hot baths, it is stated, is chronic rheumatism producing deformities of the joints, which usually resists all ordinary modes of treatment.—20 *A*, *November* 21, 1874, 588.

INTRODUCING MEDICINES INTO THE SYSTEM BY GALVANISM.

According to Herman Munk, the failures of the various attempts to convey liquid medicaments into the living human body by means of the galvanic current have been because the current has been sent in one direction alone; as he has found that, if a moist, porous body, between liquids of various conductivity, be traversed by the current, the speed of the conveyance of the liquid into this body rapidly diminishes, and soon becomes zero. If, under the same circumstances, the current is reversed, after a short interval,

the liquid enters anew from the now positive electrode. By frequently repeating this reversal large quantities of the liquid can be introduced. Mr. Munk has in this way transferred fatal quantities of strychnine solution through the unbroken skin of young dogs, and has introduced chinin and iodide of potassium into his own arm in such quantities as to be readily detected in the excreta. The essential points, therefore, in such operations are that the liquid substance be placed at both electrodes, and that the direction of the current be frequently reversed.—18 *A*, *August* 28, 1874, 614.

DIABETES HEREDITARY.

According to Dr. Schmitz, diabetes, that much-dreaded disease, is almost always the result of congenital predisposition; mental anxiety, severe pain, injuries of various kinds, etc., whether they affect the nervous system or not, being powerless to bring about the affection without an inherited tendency to it.—20 *A*, *December* 5, 1874, 635.

ACTION OF JABORANDI.

Mr. Martindale, of University College Hospital, England, gives an account of an experiment upon himself of the physiological action of the new Brazilian drug, jaborandi, which has been highly commended as a sudorific and sialagogue. An infusion of sixty grains of the bruised leaf, in five ounces of water, was prepared, and the equivalent of about fifty grains swallowed by Mr. Martindale. In a very short time he felt an increased circulation and an uneasiness in the head, with a rapid secretion of saliva. In a quarter of an hour he perspired freely, and the perspiration and salivation rapidly increased to such a degree as to blur his eyesight. The pulse rapidly rose from 96° to 104°; the perspiration poured out from all parts of the body, the saliva for a time required almost constant ejection, and the speech was affected so that articulation was difficult and indistinct. After a time vomiting came on, which threw off a portion of the solution of the jaborandi. There were many uncomfortable symptoms attendant upon the experiment, which, however, passed off after a time. The saliva collected during the experiment weighed nearly sixteen ounces, in addition to a quantity which flowed on the pillow while the patient slept.

The sweating was so excessive that the clothing was saturated, and even the bedding wetted, the perspiration passing off almost in the form of vapor.

The question of the precise botanical character of jaborandi has been a matter of considerable discussion, but according to a recent article in *The Pharmaceutical Journal*, by Mr. Holmes, there are two or more distinct varieties of the drug, one of which is very nearly, if not entirely, identical with *Pilocarpus pennatiflora;* another is from a genus not yet known; and still another from a species of *Piper*.—20 *A*, *January* 23, 1875, 92.

INTRAVENOUS USE OF CHLORAL FOR ANÆSTHESIA.

Oré, in an article upon the employment of an intravenous introduction of chloral in anæsthesia, remarks that an essential condition consists in the puncture of the vein without laying it bare. For use, one part of chloral is dissolved in three of water; sometimes, however, one part to five. Five grammes of the chloral itself in this mixture are necessary to produce satisfactory anæsthesia, and even more in some cases. Where the dose necessary for anæsthesia is from five to eight grammes, these should be introduced at the rate of about one gramme per minute, so as to allow its thorough circulation throughout the system. The advantages of this method of anæsthesia are that the respiration is never disturbed, and perfect insensibility can be secured for a period of time varying with the dose; no undue excitability is produced, and there is never any vomiting, while the operation is always followed by calm, regular slumber, which may be made to last twelve, eighteen, or even twenty-four hours, so as frequently to do away completely with the common effects of severe operations. Finally, there are never any symptoms of phlebitis, or hæmaturia, when the operation is properly performed.—6 *B*, *November* 2, 1874, 1014.

NEW PROCESS IN DENTAL SURGERY.

Mr. Napier announces what he considers to be something new in dental surgery, especially in a case where the teeth were extremely sensitive, and it became necessary to file them down for the purpose of introducing artificial teeth on the stumps. For the sake of avoiding pain in the operation,

as far as possible, ether spray was first made use of in reducing the sensibility of the teeth; a piece of cotton, dipped in ether, and laid first on the teeth and then on the instrument, being found to answer a still better purpose. While engaged in this operation, it occurred to Mr. Napier to avoid the usual practice of dentists (viz., of extirpating the nerve), with which object he took a bit of hard wood, dipped it in nitric acid, and with this cauterized the exposed portion of the nerve in each tooth successively. He then filed the teeth down to the level of the gums without producing any pain whatever. He found that in this way the stump of the tooth remained perfectly healthy, giving no pain of any kind; and the subsequent experiences of the patients were of the most satisfactory character.—20 *A*, *December* 5, 1874, 629.

CAUSE OF DISCOMFORT IN TOBACCO-SMOKING.

Quite recently Dr. Krause announced, to the dismay of smokers, that a large amount of carbonic-oxide gas is generated in the process of smoking, and that the uncomfortable feelings experienced by beginners are due to the swallowing of a portion of this. Dr. Vohl, however, disagrees with this conclusion, and thinks that the effects in question must be ascribed to the volatile organic bases which form while tobacco is burning.—12 *A*, *May* 6, 1875, 15.

PERNICIOUS ANÆMIA, A RECENTLY DEFINED DISEASE.

The Medical Times and Gazette calls attention to the existence of a disease called pernicious anæmia, not previously distinguished from the great mass of afflictions which man is heir to; referring at the same time to the gradual progress in the accurate identification and definition of diseases, and to the fact that it is but lately that such well-known affections as Bright's disease and Addison's disease have been clearly appreciated. Pernicious anæmia, it seems, very often follows chronic diarrhœa, and child-bearing appears to especially predispose to it. Those affected become extremely pale, the skin of the hands, feet, and face acquiring a swollen look. They become weak, and have attacks of giddiness and palpitation of the heart, with failing appetite, and a feeling of oppression in the epigastrium. Transient diarrhœa sometimes occurs, and feverishness without any attack of fever.

Anæmic murmurs are occasionally present with such intensity as to suggest organic disease of the heart, although none is ever found after death. With all this, the remarkable fact exists that there is very little diminution of the fat covering the body. Sometimes there are hemorrhages from the nose and kidneys, accompanied by pernicious paralyses toward the end of life, when also dropsy sometimes sets in with delirium. The course of the disease is always chronic, and the determination always fatal; and after death a fatty degeneration of certain muscles of the heart, and of some of the small blood-vessels, is noticed.—20 *A*, *November* 21, 1874, 582.

DE CHÉGAIN ON HEADACHES.

De Chégain, in a paper upon ordinary headaches, takes the ground that they result from a nervous affection of the arteries, that their starting-point is in the grand sympathetic nerve, and their precise seat is in the nervous filaments which accompany the arteries; their material phenomena consisting in the dilatation of these vessels, and the compression which they produce upon the brain and other organs, since in a genuine attack of intense headache the patient suffers everywhere: the hands are swollen, the muscles are sore, and every movement is painful. From his studies on the subject, M. De Chégain concludes that any treatment for headache should be directed against affections of the nervous system, especially of the great sympathetic, and against the arterial dilatation which results, and constitutes the essential feature of the malady, and that in this there are three points to be considered: the intermittence, the pain, and the arterial dilatation. His special treatment, founded upon the consideration of these circumstances, consists in the administration of pills composed of:

Sulphate of quinine	0.05	of a gramme.
Tannin	0.05	" "
Aconitine	0.001	" "

He prescribes one of these pills a day, although he states that, by a continuation of this treatment, those who have become accustomed to it may use three or four pills per day with marked success. The tannin appears to have a special action, illustrated by the relief experienced from the contin-

ued use of certain substances, such as Paullinia (guarana) in large quantity. Such a treatment, however, according to the author, is incomplete, as it has no reference either to the intermittence or to the pain, which are to be antagonized by the other substances recommended.—12 *B*, *Jan.* 30, 1875, 92.

CURABILITY OF PULMONARY DISEASE.

Pietra Santa, in a communication to the Academy of Sciences of Paris, takes occasion to contest the doctrine of the incurability of pulmonary disease, which in his opinion is an affection essentially general and constitutional, an alteration of the function of nutrition, and a disease of the blood. While there is no panacea for this affection, he thinks that many cases may be greatly alleviated, and, indeed, entirely cured, by following a rational treatment. This consists in the intelligent and reasonable use of sundry medicaments, of which experiment and clinical observation have shown the efficiency, and which may be summed up in the following precepts:

First, in all periods of the disease the assistance is to be invoked of suitable hygienic and moral treatment, a pure atmosphere, a tonic diet, moderate exercise, and the use of milk for food. Second, the administration of certain mineral waters. Third, a salutary change of place and of migration, always into southern temperate regions during winter, and to mountainous countries in the summer. Fourth, the use of hyposulphites and the alkaline sulphites for the treatment of the tuberculous matter developed in the lungs. Fifth, calling into play numerous agencies of general therapeutics, when they can be employed to meet the various complications connected with each period of the disease.—6 *B*, *November* 2, 1874, 979.

RELATION OF BACTERIA TO PUTREFACTIVE DISEASE.

Dr. Klein, of the Brown Institution, in London, has published a paper in reference to the relation of bacteria to putrefactive diseases, and has found, in the course of certain investigations upon the small-pox of the sheep, that the lymphatic vessels of the loose tissue beneath the skin, and elsewhere, are occupied by the branching filaments of a fungus-like organism. In the pustules which form on the sur-

face these filaments give rise to minute rounded spores, which have also been seen by other observers, and recognized as special "corpuscules" of the diseases small-pox and vaccinia. In investigating the phenomena of typhoid fever, he has ascertained that in the ulcerated intestines there are immense numbers of minute, round, yellowish-green organisms, both in the tissues of the intestinal wall and in the villi of the surface.—15 *A*, *Oct.* 31, 1874, 580.

DANGER OF EATING FISH IMPROPERLY CURED, OR CAUGHT IMMEDIATELY AFTER THE SPAWNING SEASON.

The importance of the exercise of suitable care in regard to public fisheries may be appreciated from the fact, now quite well established, that the consumption of fish improperly cured, or taken during the exhaustion following the spawning season, produces serious evils, these, among others, consisting in part of a modified form of leprosy and elephantiasis—diseases directly traceable to the cause referred to both in Norway and in India.—12 *A*, *Dec.* 31, 1874, 175.

SELECTION OF THE WATER SUPPLY OF CITIES.

A valuable report by Professor Chandler upon the sanitary chemistry of waters, and suggestions with regard to the selection of the water supply of towns and cities, has just been reprinted from papers of the American Public Health Association, the whole forming an important manual in connection with the plans of water supply for towns and cities.

Professor Chandler in this report considers the nature of the impurities contained in water and their effect upon the public health, and devotes particular attention to the pollution of streams by the refuse from factories and by sewage. He is, however, quite satisfied that a certain class of impurities, especially those of an animal nature, in time become harmless by their decay, consequent upon their combination with the oxygen in running waters; this relief, however, not applying to the case of confined wells. The experiences of the Thames coincide with those of the Hudson in this respect.

It has been calculated that sewage mixed with twenty times its volume of running water, after flowing a distance

of ten or twelve miles, is absolutely purified by infusorial animals, aquatic plants, and chemical oxidation.

The Professor makes a special application of his researches to the Croton water, and states as a general conclusion from the whole that for the supply of cities rivers and lakes are very decidedly superior to wells, which should always be viewed with suspicion, on account of the danger of contamination from the drainage of the soil, and leakages from the cess-pools and private vaults.

PICRIC ACID AS A TEST FOR ALBUMEN IN URINE.

Picric acid is recommended by Dr. Galippe as the best reagent for the detection of albumen in urine. The urine should be added drop by drop to a few cubic centimeters of a solution of the acid in water, when any albumen present will produce a characteristic cloudiness, not to be confounded with any thing else. If the picric acid is added to the urine no reaction will occur.—15 *C*, VII., 1875, 111.

SALICYLIC ACID.

Salicylic acid still continues to find favor as an antiseptic, supplanting in this respect carbolic acid and other predecessors. How long it will maintain its present position is, of course, a matter of uncertainty. This acid is slightly yellow in color, taking the form of fine crystals, which are readily soluble in alcohol and ether, as also in hot but not in cold water. It melts at 318° Fahr. When heated rapidly it is resolved into carbonic and carbolic acids. In addition to its alleged superior efficiency, it is much preferable to carbolic acid in lacking any smell and any unpleasant taste.

According to Professor Neugebauer, a small quantity of this acid is sufficient not only to prevent the second or after fermentation of wine and its consequent muddiness, but also the formation of fungi in the casks.

According to Professor Kolbe, half a gramme of the acid will check the fermentation produced by five grammes of yeast in a solution of sugar. It is said to prevent the decomposition of water on shipboard when added in the proportion of 1 to 200,000. By covering the bung-hole of the casks with cotton steeped in the acid, the filtration of the air will affect the preservation of the water within the cask.

The process of curdling in milk is retarded for thirty-six hours by the addition of 6.04 per cent. of the acid. It is peculiarly adapted for use as a dentifrice, and as a preventative of the disagreeable odor from perspiration.

For the still more important purpose of surgical dressing it arrests the smell of putrefaction without producing inflammation; and a solution of it promotes the growth of the skin over granulating surfaces. Its use internally has been suggested for those diseases which are contracted from contagion.—17 *A*, *June* 1, 84.

COMPARATIVE ANTISEPTIC EFFECTS OF CARBOLIC AND SALICYLIC ACIDS.

In repeating the experiments of Kolbe upon the antiseptic effects of salicylic acid, Müller, of Breslau, found that while $\frac{1}{1000}$ part of carbolic acid would prevent the fermentation of a ten per cent. solution of grape-sugar, as well as the same amount of salicylic acid, the latter is more effective when the solution of sugar is more dilute. Again, while 0.04 per cent. of salicylic acid retarded the souring of milk for thirty-six hours, the same percentage of carbolic acid was absolutely without effect. Still the action of salicylic acid depends somewhat upon the temperature, as Kolbe admits; and his experiments were conducted with milk at 64°, instead of full summer-heat. With urine, however, salicylic acid proved far less effective in restraining putrefaction than carbolic acid; but, on the other hand, while 0.2 per cent. of the former entirely prevented the decomposition of amygdaline after the addition of emulsine, ten per cent. of carbolic acid was required to produce the same effect. A still greater difference was found in their restraining action upon ptyaline, liver-ferment, and pepsin. The decided effect upon the action of the latter does not harmonize with its effect within the organism, as Kolbe took from fifteen to twenty-two grains per day, for several days, without experiencing any injurious effects, and Müller repeatedly took from four to eight grains without its producing disturbance of digestion. The rapid excretion of the salicylic acid is suggested by the latter in explanation of this apparent contradiction, as it was detected in the urine two hours after it had been taken, and none could be detected after twelve hours. He

also regards the superior restraining effect of salicylic acid upon fermentation and putrefaction as due to the added effect of its acid properties, which carbolic acid does not possess.

JABORANDI, A NEW BRAZILIAN REMEDY.

A medicinal product from the *Pilocarpus primatus* of Brazil, known as *jaborandi*, is claimed by Dr. Coutinho, of Pernambuco, to be a very valuable remedy in many diseases, especially as a diaphoretic and sialagogue. An infusion of four to six grammes of the leaves, in a cup of cold water, produces in a short time an excessive perspiration and salivation. The saliva flows in so great abundance that as much as a liter has been collected in less than two hours. The bronchial secretion is also increased. The after-effects of this remedy are claimed to be perfectly inoffensive. The promptness of its special action is of great importance in many diseases, and it is thought that an important future is in store for this new substance.—12 *B*, *March* 30, 1874, 282.

ACTION OF AIR ON THE LUNGS IN CERTAIN CASES.

According to Dr. Bert, exposure to the air of certain pyritiferous subterranean recesses, such as caves or mines, produces all the symptoms of mountain-climbing, including syncope, the result being, as supposed, in the diminution of the amount of oxygen, caused by the iron pyrites, which passes gradually to the condition of a sulphate.—13 *B*, *April* 18, 1874, 203.

HYDRATE OF CHLORAL IN INFANTILE CONVULSIONS.

According to Derim, the hydrate of chloral is almost a specific against the occurrence of convulsions in children, especially where these result from some trifling cause, such as difficult dentition, intense emotion of any kind, etc.; and even in a case where there is some severe local cause it is said to prevent convulsions, and allow the administration of proper remedies. The preparation of Dr. Derim contains one gramme, or fifteen grains, of the chloral, this being given every half hour, or even every quarter of an hour in urgent cases, until the convulsions cease and quiet respiration succeeds.—11 *B*, *April* 1, 1874, 174.

O. MISCELLANEOUS.

REPORT OF THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, FOR 1874.

The report of the American Museum of Natural History for 1874 has just been published by the directors. The rapid progress that has been made in the enterprise is best shown by the announcement that the corner-stone of the new fire-proof building was laid during the year, and that it will probably be completed in the course of the year 1875.

The more important additions to the collections of the museum during the year have been the conchological cabinet of Dr. John C. Jay, embracing 50,000 specimens, and a valuable library of conchological works of about 1000 volumes. Mr. R. A. Witthouse has presented 2000 species of American coleoptera. A series of sixteen skeletons of the gigantic moas, or fossil birds of New Zealand, has been received in New York. The department of anthropology has been enlarged by the purchase of the collections of Indian antiquities made by Dr. E. H. Davis and by E. G. Squier, and that of mineralogy by the purchase of a collection of minerals, embracing 7000 cabinet specimens.

During 1874 $13,000 were subscribed for the purchase of new and attractive collections, which sum was invested in procuring the series just mentioned. There is at present no definite endowment to meet the expenses of the museum, the institution being dependent for this upon the contributions of its annual members, who pay $10 each. Subscriptions of $100 and upward are reserved for increasing the collections. The membership has been augmented during the year from 350 to 1100, and it is hoped it will soon be sufficiently large to furnish all the means necessary to secure the best scientific assistance in the various branches of the museum.

KIRTLAND SCHOOL OF NATURAL SCIENCES.

The Kirtland School of Natural Sciences, established in Cleveland, Ohio, concluded its course on the 9th of August.

The school consisted of twenty members, of whom thirteen were ladies, and lasted for five weeks, during which time gratuitous instruction was given by lectures and otherwise, and short excursions were made in connection with the subjects of study. Dr. Newberry, Professor Theodore B. Comstock, Professor Albert Tuttle, and Dr. William K. Brooks were the instructors.

The operations of the school were mainly conducted by Professor Comstock. Facilities were extended by railroad and steamboat companies in the transportation of the school and in various interesting excursions.

NORMAL SCHOOL OF NATURAL SCIENCES.

Among the other natural-history schools conducted during the past summer, somewhat on the plan of that at Penikese, was one at the town of Normal, in Illinois, which closed on the 11th of August, after a four weeks' course. The class was divided into sections, each section working in concert on the same subject, under the guidance of an instructor. Thirty lectures were delivered, one or two each day, having close relation to the laboratory work.

The instructors consisted of Professor Burt G. Wilder, Professor W. S. Barnard, Professor T. G. Burrall, Professor Cyrus Thomas, and Professor S. A. Forbes.

The materials for the zoological course were abundant, being derived partly from Lake Michigan and the Illinois River, and partly from the New England coast, gathered principally by Professor Van Vleck, at Wood's Hole, the head-quarters of the United States Fish Commission. It was stated that a greater variety of animals was available for study than at Penikese itself. Among others was a supply of the lancelet, or amphioxus, the most rudimentary of known vertebrates, received by Professor Wilder from Naples.

FIRST ANNUAL REPORT OF THE ZOOLOGICAL SOCIETY OF CINCINNATI.

The first annual report of the Zoological Society of Cincinnati for the year 1874 has been published, giving an account of the present condition of that important enterprise. From this we learn that, after various efforts to secure a

proper site, a suitable locality was obtained in the southwestern corner of Avondale, of 66 acres, for which a reasonable annual rental is to be paid. About $120,600 have been raised in the form of capital stock, and this, with the regular receipts, will be quite sufficient for carrying on the establishment and furnishing handsome interest on the investment. The gardens of the Society, containing fifty-six acres, were opened to the public on September 18th.

FIRST ANNUAL REPORT OF THE GEOLOGICAL AND AGRICULTURAL SURVEY OF TEXAS.

Dr. S. B. Buckley has published his first annual report of the Geological and Agricultural Survey of Texas, in which he gives an account of the labors of his predecessors and of his own operations during the year. In addition to a general sketch of the economical geology of the country, we have tables of precipitation and temperature, an indication of the principal soils and animal and vegetable products, etc., with a reproduction of a defense made some years ago by the author against criticisms by Professor Gray in regard to certain species of Texas plants described by him as new.

ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES FOR 1873.

One of the most important of the many valuable government documents is the Annual Report of the United States Geological and Geographical Survey of the Territories for 1873, as prepared by Dr. Hayden, being a volume of 730 pages, profusely illustrated with plates and sections, and exhibiting the physical geography, the sectional geology, the mining, and the natural history of the country.

The volume consists of several sections. The first—that of geology, mineralogy, and mining industry—was prepared by Dr. Hayden, Mr. Marvine, Mr. Peale, and Dr. Endlich. The second embraces special reports on paleontology, on the fossil flora by Professor Lesquereux, and on the vertebrates by Mr. Cope. Part third—zoology—contains articles on the recent invertebrates, by Lieutenant Carpenter, Dr. Packard, Baron Ostensacken, Mr. Ulke, Dr. Hagen, Mr. S. J. Smith, Professor Verrill, and Mr. William G. Binney. Part fourth—

upon the geography and topography—is from the pen of Mr. James T. Gardner, geographer of the expedition. There is also an appendix, by Mr. A. R. Marvine.

The book is, of course, indispensable to all persons interested in the physical geography and natural history of the West.

ARRANGEMENTS FOR A BOTANICAL GARDEN IN CHICAGO.

A commendable enterprise has been initiated in Chicago, by the South Park Commissioners, in the setting apart of sixty acres for the establishment of botanical gardens, this space to be increased from time to time as occasion may require. The general management of affairs is in charge of the board, of which Mr. N. H. Hibbard is president and H. H. Babcock secretary.

It is proposed to have a botanic garden proper, provided with suitable houses for the reception of plants requiring protection, an arboretum, a garden for general floriculture, a botanical museum, an herbarium, and a botanic library. A circular has been issued by the board of managers, soliciting contributions to the several departments of the garden, especially of seeds, cuttings, living plants, and herbarium specimens. This solicitation is made with the expectation of being able to make proper return for such contributions at an early day. The general direction of the establishment has been placed in charge of Mr. H. H. Babcock.

THE CHESS PROBLEM OF THE EIGHT QUEENS.

The chess problem proposed by Nauck to the distinguished mathematician Gauss, viz., to determine the number of ways in which eight queens can be placed on a chess-board so that no one can take or be taken by any other, has been completely solved by Gunther, whose solution has been somewhat improved by Mr. J. H. L. Glaisher. According to these gentlemen, for a chess-board of sixteen squares and four queens there are two solutions of the problem, in a board of twenty-five squares, ten solutions, and in a board of sixty-four squares, with eight queens, ninety-two solutions. Of these ninety-two solutions, one is perfectly symmetrical, and is given by Mr. Glaisher in full.—7 *A*, XLVIII., 456.

REPORT ON THE POPULATION OF THE EARTH.

The number of Petermann's *Mittheilungen* for March, 1875, contains the usual annual report upon the population of the earth, made by Messrs. Behm and Wagner. The footing for the year 1874 is as follows:

Europe	302,973,000
Asia	798,907,000
Africa	206,007,000
America	84,392,000
Australia and Polynesia	4,563,000
Total	1,396,842,000

—17 *C, March*, 1875.

JAPANESE GAME OF CHESS.

In a recent number of the proceedings of the German Society at Yokohama, an interesting account is given by Holtz of the Japanese game of chess. The chess-board is, he says, divided into eighty-one squares of the same light yellow color, which are distinguished among themselves by drawing black lines over the yellow board. The squares are not true squares, but somewhat longer than broad, in order to correspond to the figures of the chess-men themselves. The figures are, like the board, of the same color, but of a more decided yellow, perfectly distinguishable from that of the board itself. In the English game we have thirty-two pieces and sixty-four squares. In the Japanese we have forty pieces and eighty-one squares. The separate figures are of different sizes, in proportion to their value, but have all the same shape, *i. e.*, very nearly that of a truncated pyramid. The queen is the greatest, the peasants the smallest; but the difference in size between the separate figures would scarcely suffice to prevent mistakes, if it were not that the name and value of each figure are written in Chinese letters upon their upper sides. Except the queen and certain other figures, they all have also a second sign on their bases, which bases are turned uppermost during the first part of the game, and only turned down when the piece itself has reached the enemy's side of the board. The pieces are so placed upon their squares that the narrower sides are turned toward the opponent, so that one at a glance easily recognizes

each of the figures belonging to the other party. In this way the Japanese, by the position of their figures, attain the same end that the Europeans accomplish by differences of color. Concerning the movements of the pieces, which Holtz describes in detail, we will only state that the king's moves are very similar to those in the European game. There is no piece whose movements correspond to those of the queen in the English game.—*Mitth. Deutsch. Gesell., Yokohama, July*, 1874, 13.

REPORT OF THE ICELANDIC COMMISSION TO ALASKA.

During the summer of 1874 a committee of the Icelanders resident in Wisconsin visited Alaska for the purpose of ascertaining whether that country would be suitable for an emigration of Icelanders from their native island. The Secretary of the Navy furnished them transportation on board the *Portsmouth*, and secured to them ample opportunity of making the examination in question. Their report has just been printed by the government, from which we learn that the investigation was highly satisfactory to the committee, and tended to dispel many of the prevalent ideas as to the character and value of the region.

On Cook's Inlet the committee found large varieties of fine timber and an unexpected amount of summer weather, the winter beginning as late as the middle of November and ending the middle of March. They were informed by a resident that cabbages, potatoes, and other garden vegetables grew readily, and that nothing else, to his knowledge, had ever been tried. He stated, however, that there was a settlement near by where rye was raised. They were very decided in their impression of the advantages which the island of Kodiak would furnish to the people of their country, there being an abundance of timber east of the 151st meridian; west of that it was open plain, with plenty of excellent pasturage. Potatoes they found to do well, as also cabbages, turnips, and other vegetables. They considered that any thing which grows in Scotland would succeed in Kodiak. Pasture land they found admirable all along the coast, and considered it probable that it was equally good in the many valleys which lead from the bays to the inte-

rior. Fish were very abundant, salmon being in the greatest profusion, while codfish and halibut were also very plenty, and were caught without boats, fishing from the wharf or rocks. They corroborate very emphatically the general accuracy of Mr. Dall's report of the country as contained in "Alaska and its Resources," and consider him correct in all essential matters. The land in every respect has advantages over Iceland, the climate being milder in winter without being warmer in summer, and the summer lasting longer than it does in Iceland. "They therefore do not hesitate to recommend those of their countrymen who are minded to emigrate to do so, and they make this recommendation after conscientious deliberation, and in the firm belief that it would be for their advantage, the land appearing in every respect adapted to their needs, and answering completely all their expectations."

BEQUEST TO THE CINCINNATI SOCIETY OF NATURAL HISTORY.

The Cincinnati Society of Natural History has lately received a bequest of $50,000 from Mr. Charles Bodman, of that city. The gift is absolute and without conditions. Mr. Bodman was a member of that society, and has thus endeavored to place it on a permanent basis, and enable it to become one of the prominent institutions of Cincinnati.

SCIENTIFIC BALLOONISTS.

The investigation of the atmosphere by means of observations in balloons has, during the past few years, been prosecuted with marked activity by the French aeronauts, who have organized the French Society for Aerial Navigation. This society, having clearly seen that ascensions, to be of value, must either aim at attaining great heights or at remaining a long time in the atmosphere at moderate heights, undertook during the present year one voyage of each description, the first of which was that of the 23d of March, the object being to secure a long duration. The ascent was made from the gas-works at Villette, near Paris, at 6.20 in the evening; the descent was made on the following day at 5 o'clock, the entire voyage having lasted twenty-two hours and forty minutes. Among the apparatus taken with them,

besides those pieces that are the invariable accompaniments of such expeditions, there was a Davy's lamp for illumination at night, two beautiful spectroscopes, and an instrument by the aid of which it was easy to determine the velocity of the wind—that is to say, the velocity of the horizontal movement of the balloon. Tissandier also experimented with the aspirator to determine the quantity of carbonic-acid gas. Sivel introduced, apparently for the first time in French aeronautics, the guide-rope, with which American readers are familiar from its usefulness in the expert hands of Mr. S. A. King, of Boston. The rope used by Sivel was, however, some 4000 feet long, and it was intended that it should generally touch the earth and glide along over the soil, thus acting as a rudder to the vessel, giving a certain fixed direction to the car of the balloon, and preventing its gyration. Sounding balloons, as they were called, were also devised by Sivel. One of them was filled with illuminating gas, the other with air, and these two balloons, fixed at the end of a horizontal rod, floated one above and one below the car, and always indicated the relative upper and lower winds. During the night the altitude of the balloon oscillated between 700 and 1100 meters, the temperature being between 1° and 4½° C. Cirri were always above the balloon, increasing during the night, and giving rise to a magnificent halo in the morning on the rising of the sun. The moon was also surrounded by a similar halo. A moderate southwest wind had been predicted from the consideration of the weather charts, and was actually experienced, replacing the northeast wind with which they started. The balloon followed the prominences of the soil very exactly, being pushed up over the hills by the ascending current whenever it came to any elevation. This fact was especially manifest in that portion of the voyage during which the altitude was but 600 meters. The balloon itself was frequently inclined out of the vertical. Very appreciable variations in the velocity of the wind were experienced, amounting to between five meters per second during the night and ten meters at sunrise, and diminishing in the upper regions, contrary to the usual experience. Slight traces of electricity were observed at sunrise, but not during the night.—*Bull. Hebd.*, XVI., 33.

INDEX OF PATENTS FROM 1790 TO 1873.

A very important work has just been commenced by the Patent-office, under the title of "Index of Patents for Inventions issued by the United States Patent-office from 1790 to 1873, inclusive. Compiled and published under the direction of M. D. Leggett, Commissioner of Patents." The first volume, a royal octavo of 649 pages, was published in 1874, and the remaining volumes will follow in rapid succession.

The method adopted is strictly alphabetical, the subjects being given in their alphabetical sequence, with name of inventor, his residence, and the date and number of the patent. Should full details in regard to any invention be desired, they can be obtained, of course, by reference to the original patent.

DECIPHERING CHARRED MANUSCRIPT.

A large number of valuable papers that had been charred, apparently to a homogeneous mass, during the Communist rule in Paris, have been deciphered by Rathelot. He first severed the leaves by cutting the backs of the books and immersing the mass in water, then subjected it to a tolerably high temperature at a hot-air stove. The leaves, thus loosened from each other by the rapid vaporization of the water, were with great care separated, and were immediately transcribed, the writing being quite legible, as the letters appeared dull upon the glistening black surface of the paper.—8 *C, Sept.* 24, 1874, 347.

ASTRONOMY IN BRAZIL.

The Imperial Astronomical Observatory of Brazil is a dependence of the Central College of Rio Janeiro, and is destined not only to teach practical astronomy to the students, but to make and publish astronomical and meteorological observations. The chronometers of the navy and army are there regulated, and the time is given daily by signal to the city. The building is situated on an eminence within the city, and the government is now taking measures to improve its scientific character. The director is at present in Europe, with a view of procuring such instruments and apparatus as may be adapted to the studies required of the institution.

An entire reorganization of the observatory is under way, with the purpose of training more thoroughly the persons charged with geologic and geodetic works. There is also an observatory at the capital of the province of Pernambuco.—"*The Empire of Brazil*," p. 293.

ASTRONOMY IN CHINA.

The astronomical instruments sent by the Academy of Paris to China are to remain at Pekin, and possibly a permanent observatory may be established there. The French astronomers who are at Pekin report that the instruments set up by the Jesuit missionaries in the last century are still in perfect order. We believe that the American astronomers were instructed to inquire whether the original observations made by these missionaries were still in existence, and whether they would possibly, in some respects, be worthy of the attention of astronomers of the present day.

SUMS VOTED BY THE BRITISH PARLIAMENT FOR SCIENTIFIC INSTRUCTION.

It will probably be many years before the United States, as a nation, follows the example of Great Britain to any considerable degree in making grants for the purposes of scientific education and instruction. The following table will show the amount voted by Parliament in 1874 for a few of these establishments:

British Museum	£102,442
Kew Gardens and Museum	17,862
Geological Museum	8,998
Edinburgh Museum of Science and Art	9,824
Dublin Museum of Natural History	1,672
Dublin National Gallery	2,380
Museum of the Royal Irish Academy	2,084
Total	£145,262

—15 *A*, *Feb.* 13, 1875.

METEOROLOGY IN CHINA.

The Jesuit college of Zi-ka-wei, near Shanghai, China, has lately begun the publication of the meteorological observations taken by the fathers at the college. These have been made three times a day since 1868, and are printed upon

monthly sheets, the first of which contains the observations for December, 1872. Notwithstanding the southern latitude of Shanghai, it is noted that there were forty-nine days of freezing temperature during the four months from 1872 to March, 1873, the minimum temperature being 16° Fahr. on the 31st of January. Shanghai is 5½° farther south than New Orleans. The instruments used at Zi-ka-wei are approved modern standards, similar to those adopted in France by St. Clair Deville.—*Nouvelles Météorologiques, Société de France.*

FOURTH MEETING OF THE FRENCH ASSOCIATION.

The fourth annual meeting of the French Association for the Advancement of Science took place at Nantes in the end of August, closing on the 26th. The session was a satisfactory one, and very largely attended, and many important papers brought forward. The meeting for 1876 is to be held at Clermont Ferrand, and that for 1877 at Havre.

ANNUAL REPORT OF THE COUNCIL OF THE ZOOLOGICAL SOCIETY OF LONDON.

The annual report of the Council of the Zoological Society of London, made April 29, contains the usual record of prosperity of this world-renowned establishment. The total enumeration of members of different grades at the close of the year 1874 is given at 13,197, a considerable number having been added during the year. The only foreign member elected was Mr. Alexander Agassiz, to fill the vacancy caused by the death of his father. Of corresponding members the only American elected was Dr. H. C. Yarrow, of Lieutenant Wheeler's survey.

The income of the society for 1874 was the largest since its foundation, amounting to about $142,000, of which the receipts from the Zoological Garden were about $84,000. This is a diminution compared with the receipts of the previous year, due largely to the unfavorable weather of certain special holidays.

The total number of visitors to the gardens during the year amounted to about 707,000, exceeded previously only by the numbers in 1873.

The Council announced that a series of lectures was to be

delivered during 1875, upon popular subjects connected with the living animals of the menagerie, principally by Dr. Sclater, Mr. J. W. Clarke, Professor Garrod, Professor Flower, and Professor Mivart.

Among the additions to the menagerie during the year, the most important is that of a rhinoceros from Java, making the fourth species of the genus now living in the gardens. The whole number of additions of all kinds amounted to 1202, of which 425 were donations.

INTERNATIONAL CONGRESS OF SILK-CULTURISTS.

An International Congress of Silk-culture is to be held at Milan during 1876, and circulars have been distributed inviting a series of experiments to be made during 1875, and a report on the results. This has reference to various points connected with the keeping of silk-worms, the prevention of injurious diseases, particularly of their "inactivity," a disease which has produced great injury of late years.—12 *A*, *April* 6, 1875, 456.

REPORT OF ROYAL COMMISSION OF SCIENTIFIC INSTRUCTIONS.

The final report of the Royal Commission on scientific instruction and the advancement of science, which has been engaged for a number of years past in investigating the question of high scientific education and the relations of science to the state, has just been published, being the eighth of the series. The conclusions to which it has attained are, in brief, as follows:

First. It finds that the assistance given by the state in Great Britain for the promotion of scientific research is inadequate, and that the concession or refusal of assistance does not take place on any definite principle.

Second. That more complete means are urgently required for scientific investigations in connection with certain government departments, and that physical as well as other laboratories and apparatus should be provided.

Third. Certain classes of phenomena, such as those relating to physical meteorology and terrestrial and astronomical physics, require observations of such a character that they can not be advantageously carried on otherwise than under the direction of the government. Institutions for the study

of such phenomena should, therefore, be maintained by the government especially, and an observatory established devoted to astronomical physics, and an organization for the more complete observation of tidal phenomena, and for the reduction of observations.

Fourth. Aid should be extended to persons engaged in important physical and chemical investigations, as is now done to those connected with the government collections of natural history.

Fifth. While grants of money, merely covering actual outlays of expenses in certain investigations, have been made, it is quite proper that something more than this should be done under certain circumstances, especially where a competent individual engaged in some important research is unable to meet his own personal expenses.

Sixth. The grant of £1000 administered by the Royal Society has been of so much benefit as to warrant a considerable increase.

Seventh. A ministry of science and education should be created for the proper disposition of the funds for research, and the general supervision of scientific work as connected with the state or controlled by it.

Eighth. The services of such a ministry of science and education would be greatly furthered by being associated with a scientific council of the Royal Society, representatives of other important societies, and a number of persons nominated by the government.

These conclusions are unanimously indorsed by all the members of the commission, consisting of the Earl of Devonshire, Lord Lansdowne, Sir John Lubbock, and Messrs. P. Kay-Shuttleworth, Bernard Samuelson, W. Sharpey, Thomas H. Huxley, C. G. Stokes, and Henry J. S. Smith.

BELGIAN EXHIBITION OF 1876.

Belgium announces for the coming year an exhibition of quite novel and eminently praiseworthy character, namely, an exhibit of apparatus designed in any manner to save life or health. The project has been undertaken at the suggestion of the Société Royale des Sauveteurs de Belgique, whose labors and publications in the cause of humanity are warmly acknowledged. A feature of the exhibition will be

the experimental trial of apparatus as far as this is practicable. Experiments on the river or the sea will take place at Antwerp or Ostend, and the factory owners have signified their desire to co-operate in aiding the conduct of such trials as can only be made in workshops and factories.

The following is a summary of the several heads or classes under which exhibition is desired:

Class I. Preservation of life in case of fire.

Class II. All apparatus, engines, etc., for the preservation of life in or on water, or for the prevention of danger to the same.

Class III. Apparatus for the prevention of accidents in crowded thoroughfares, tram-ways, and railways.

Class IV. Assistance in time of war.

Class V. Medical and sanitary arrangements for the preservation of public health.

Class VI. Means of prevention of accidents and of safety as applied to industry.

Class VII. Domestic and private medical arrangements.

Class VIII. Medicine, surgery—pharmacy in connection with the preceding classes.

Class IX. Institutions for improving the condition of the working classes.

Class X. Health in connection with agriculture.

TWELFTH CONGRESS OF THE ITALIAN SCIENTIFIC ASSOCIATION.

The twelfth congress of the Italian Scientific Association was held at Palermo, beginning on the 29th of August.

ROYAL SOCIETY'S CATALOGUE OF LEARNED SOCIETIES AND SCIENTIFIC PAPERS, 1864–73.

The catalogue of such memoirs and articles as have been issued during the decade from 1864 to 1873, in the publications of learned societies and scientific magazines, promised some time since, will be soon made ready for printing by the Royal Society of London. The necessary funds for its completion have been granted by the council of the society, and it is expected that the British government will furnish the means for printing it, as it did for the six volumes covering (in one series) the years 1800 to 1863. It seems that those six volumes cost in all £8936 12*s*., of which £3720 15*s*. 6*d*. were spent in the preparation of the work for press, and defrayed by the Royal Society, and the rest was expended for printing, paper, and binding at the cost of the government. The work has been a public benefaction to all persons in-

terested in scientific research, and the new volume will be eagerly looked for.

MEETING OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The fourth annual meeting of the American Fish-culturists' Association was held in New York on the 9th and 10th of February, 1875, and the proceedings have just been published under the direction of Mr. A. S. Collins, of Caledonia, New York, the secretary of the association. There was a large attendance present, and many interesting papers were presented.

The society is not limited to the United States, but includes quite a number of members from the Dominion, one of these, Mr. W. F. Whitcher, the Commissioner of Fisheries, being a member of the Executive Committee.

Among the most important papers presented were one by Mr. Frederick Mather, on the "Poisoning and Obstruction of Waters;" one by Seth Green, on "Stocking Depleted Waters;" by Samuel Wilmot, on "Aqua-culture and Fish Protection;" by Mr. Salter, on "Fish-culture in China, and the Chinese Shad;" by Thaddeus Norris, on the "Introduction of the Michigan Grayling into Eastern Waters;" and by James Worrall, on "Pennsylvania Fish-Ways."

There are at present about eighty members of the association.

PROCEEDINGS OF THE CENTENNIAL OF CHEMISTRY.

The proceedings of the Centennial of Chemistry, held August 1, 1874, at Northumberland, and published in the August, September, and December numbers of the *American Chemist*, 1874, have just been reproduced in a neat quarto volume of 211 pages, under the editorship of Professor H. C. Bolton. In addition to the account of the proceedings, there is a sketch of the life and labors of Priestley by Professor Henry H. Croft; an address at his grave by Professor Coppée; an address by T. Sterry Hunt, on "A Century's Progress in Chemical Theory;" by Professor J. Lawrence Smith, on "The Century's Progress in Industrial Chemistry." The most important component of the volume is an account of American contributions to chemistry, in an address by Professor Benjamin Silliman, containing a list of all Amer-

ican chemists for the past century, with a detailed enumeration of their memoirs.

NATIONAL PARK IN THE ISLAND OF MACKINAW.

One of the enactments of the recent Congress in the interest of the public was the setting aside of a large part of the island of Mackinaw, Michigan, as a national park, all of the land in that vicinity owned by the United States, with the exception of a certain portion required for military purposes, having been placed under the charge of the Secretary of War for the purpose in question, with the condition that all persons who shall settle on or occupy the same, excepting under conditions specified, shall be considered trespassers, and removed therefrom. It is made the duty of the Secretary of War to establish such regulations as he may think best for the proper protection and preservation of the trust. He is to provide for the preservation of the timber, the mineral deposits, natural curiosities, etc. He may, at his discretion, grant leases for a term not exceeding ten years, at places where the erection of buildings for the accommodation of visitors is desirable, and all the proceeds of said leases are to be expended in the construction of roads and bridle-paths. The wanton destruction of game and fish found within the limits of the park is to be provided against, and all trespassers are to be duly punished.

ANNUAL REPORT OF THE LIBRARIAN OF CONGRESS.

The annual report of the Librarian of Congress for 1874 has just been published. From this we learn that the additions during the year consisted of 15,405 books and 6272 parts of books and pamphlets, of which 1264 volumes and 1756 parts of volumes were received from the Smithsonian Institution, and 6840 volumes by copyright. The total number of copyrighted articles, including books, periodicals, musical compositions, dramatic compositions, photographs, engravings, and chromos, maps, charts, drawings, and prints, amounted to 29,674. The copyright entries for the year exceeded those of the previous year by 931. The amount paid into the Treasury on account of copyright fees was $13,524 78.

Mr. Spofford, the librarian, again calls the attention of

Congress to the great importance of a library building for the accommodation of the constantly increasing collections, which have already grown far beyond the bounds of the present library halls.

ADDITIONAL PAY TO THE SURVIVORS OF THE "POLARIS."

An act was passed by the recent Congress providing for the payment to the survivors of the *Polaris* in the arctic expedition under command of Captain Hall, their widows or minor children, of a sum of money, in addition to that already paid, equal to one year's pay which each would have been entitled to respectively, if continued in the service, under rules and regulations prescribed by the Secretary of the Navy for the said exploring expedition, and that the sum of $360 each be paid to the Esquimaux Joe and Hans.

The act further provides that if any sale, assignment, or transfer shall be made of any interest in the gratuity provided by this act, the amount so assigned shall revert to the government of the United States.

The act does not include Mrs. Hall in its provisions, as she has received the sum of $15,000 from the government for the manuscripts of Captain Hall.

THE LYELL MEDAL.

Sir Charles Lyell has left to the Geological Society of London the sum of $10,000, one third of the interest of which is to be applied annually to furnish a medal in bronze, called the Lyell medal, as a recognition on the part of the society of merit on the part of the medalist. The remainder of the interest is to be given in one or more portions, at the discretion of the Council, for the encouragement of geology or any of its allied sciences, either for traveling expenses or for a memoir or paper published. It is to be given without reference to the sex or nationality of the author, or the language in which it is written.—12 *A*, *April* 1, 1875, 434.

ANNUAL RECORD OF PUBLICATIONS IN GEOLOGY, MINERALOGY, AND PALEONTOLOGY.

An annual record of publications in geology, mineralogy, and paleontology has been undertaken, to correspond in plan with the *Zoological Record*, so serviceable to natural-

ists. The first volume will be printed by the middle of 1875, to contain an account of publications for 1874. The work will probably occupy from two to three hundred pages, and be sold at 10*s.* 6*d.* Among those who will take part in the work are Messrs. Carruthers, De Rance, D. Forbes, Professor Geikie, Professor T. R. Jones, L. C. Miall, Dr. H. A. Nicholson, Henry Woodward, and others. Authors of articles on the above-mentioned subjects are requested to forward copies for the purpose of having them properly noticed.—12 *A*, *Oct.* 22, 1874, 511.

LOAN EXHIBITION OF SCIENTIFIC APPARATUS.

The scientific department of the Committee of Council on Education, South Kensington, England, is preparing to make a loan exhibition of scientific apparatus in 1876, to begin on April 1st and last till the end of September. This will consist of instruments and apparatus employed for a variety of scientific purposes, as also of articles illustrating the progress of science and its application to the arts, with any specimens that may be supposed to have an interest on account of the persons who employed them. Drawings, photographs, etc., will also be admissible where the originals can not be sent. Special efforts are being made to render this collection complete, and Mr. W. Cunliffe Owen, director of the South Kensington Museum, has applied to various scientific establishments of this country—as the Smithsonian Institution—for such specimens as may be considered desirable in this connection.

LIST OF THE MERCHANT VESSELS OF THE UNITED STATES.

The Statistical Bureau of the Treasury Department has published a list of the merchant vessels of the United States, with the official numbers and signal letters awarded them—a volume of nearly six hundred pages. This contains, first, a list of the merchant vessels, alphabetically arranged; second, a list of the unrigged merchant vessels, alphabetically arranged; third, a list of sea-going vessels, with signal letters arranged in their regular order; fourth, a supplemental list of vessels, officially numbered, up to June 30, 1874; fifth, a list of vessels in the revenue service; sixth, a list of vessels belonging to the United States Navy in 1874; sev-

enth, a complete list of the vessels of the United States Navy from 1797 to 1874, together with the lists and numbers of the line, staff, and other officers, both active and retired.

This report is the sixth full statement of the kind, required by an act of Congress of 1866, and contains a new and very important feature in the list of sea-going vessels, with the signal letters assigned them, by reference to which shipmasters can readily ascertain the name, tonnage, and home port of any vessel exhibiting her signals at sea.

INTERNATIONAL ASTRONOMICAL SOCIETY.

The sixth biennial meeting of the International Astronomical Society, founded in 1863 at Heidelberg, took place from the 13th to the 16th of August, at Leyden, and was opened by the president, O. Struve. The representatives appear to have been from Germany, Holland, Russia, Norway, Mexico, and Java, no French, English, or American names being recorded among those present. It was stated that the actual number of members is two hundred and thirty-five, embracing some of the most eminent names in astronomical annals. All the manuscripts of Professor Hansen had been recently presented to the society. Professor Struve was re-elected president for the coming year.

ANNUAL REPORT OF THE PEABODY MUSEUM OF ARCHÆOLOGY AND ETHNOLOGY.

The annual report of the trustees of the Peabody Museum of Archæology and Ethnology, brought up to April, 1875, comes appropriately dressed in mourning, on account of the death of its first director, Professor Jeffries Wyman, whose loss American science was called upon to deplore some time in September, 1874. After his decease the establishment was placed in charge of Professor F. W. Putnam, who has made up the present report in part from Professor Wyman's notes. It is well known that the Peabody Museum is extremely rich in objects of European prehistoric civilization. Indeed, it may almost be said that no one European museum has a larger and more varied collection of specimens belonging to the Stone Age of different parts of that continent. Its additions of most note, however, during the past year, consist in a number of earthenware dishes and vases, obtained near

New Madrid, Missouri, and elsewhere in that state, by Professor J. C. Swallow, and purchased from him for the sum of $1500. An immense variety of curious vases, pots, and other articles was obtained, the former contracted at the top, where human and animal figures of considerable excellence of execution are represented. A very interesting portion of the report is that in which Professor Putnam details the results of his visits to sundry caves in Kentucky and Indiana, and especially his discovery, in places far removed from the entrance, of foot-prints of the prehistoric races made in the dust, together with sandals of grass, various articles of dress, and clothing materials.

P. NECROLOGY.

In this list are embraced some names of noteworthy persons deceased in 1874, but not included in the *Annual Record* for that year.

Adami, Carl Ludwig. Known in Germany as a manufacturer of globes. Died at Potsdam, January 23d.

Aitken, W. C. A member of the Society of Arts, and author of many papers on ancient and modern metal-working. Died in Birmingham, March 24th.

Andree, Dr. Karl T. Author of valuable geographical works; editor or translator of several treatises of a similar character, the most important being the "Geography of the Commerce of the World." Died August 16th, aged sixty-eight.

Argelander, Professor W. A. An eminent German astronomer. Superintendent of the Observatory of Bonn. Author of a celestial atlas comprising all the stars to those of the tenth magnitude. Born at Munich, March 22d, 1790. Died at Bonn, February 17th, aged almost eighty-five.

Barnes, M. Thomas. An African traveler and geologist. Died May 8th, on his way toward the Tattin.

Baudelot, Professor E. A distinguished French physiologist and naturalist. Author of several papers on the anatomy and physiology of the mollusks and radiates. Died February 23d, at the age of forty.

Becker, Carl L. C. Well known in England as a constructor of electrical and physical apparatus. Born in 1821. Settled in London in 1845.

Brasseur de Bourbourg, Abbé. A distinguished traveler, especially zealous in the study of the archæology of the New World. Author of "The History of the Civilization of the Ancient Mexicans and Central Americans;" as also of a large number of memoirs illustrating his discoveries. Born at Bourbourg, in France, in 1814. Died at Nice, January 8th, 1874.

Bradley, Dr. Leverett. A well-known inventor and manufacturer of practical electrical devices, such as telegraph machines, helices, etc. Died at Jersey City, September 6th, at the age of seventy-six.

Burkart, Dr. J. H. Author of travels in Mexico and of a geological map of that country. Died at Bonn, in Germany, in November, at the age of seventy-six.

Cairns, Professor. As a chemist his researches were especially upon the sulphur compounds, the oxysulphides of phosphorus, etc. Died at Marburg, April 17th, at the age of forty-six.

Campbell, Dr. Archibald. A British medical officer, resident at Dar-

jeeling, in India, the sanitarium for the British army in Bengal. A high authority on the geography, natural history, ethnology, and geology of India and Central Asia. Died in London in the seventieth year of his age.

Collomb, Edward. Treasurer of the Geological Society of Paris. A companion of Professor Agassiz in Alpine travel, and of Verneuil while studying the economical mineralogy of certain portions of Spain. Died in June.

D'Arrest, Professor Henri Louis. Professor of Astronomy at the Universities of Leipsic and of Copenhagen. Discoverer of several comets and an asteroid. Born at Berlin. Died June 14th, in the fifty-third year of his age.

Deshayes, G. B. An eminent and veteran conchologist of Paris. Died June 9th.

D'Halloy, D'Omalius. A Belgian geologist, and author of many memoirs on geological subjects. Born in Liege, February 16th, 1783. Died January 15th, at the age of ninety-two.

Diehl, Israel S. A zealous collector of objects of Natural History, and at one time United States Consul at Batavia. Aided in the introduction of a large number of Cashmere goats into the United States. Died near Gettysburg, in Pennsylvania, January 4th, at the age of forty-nine.

Doubleday, Henry. An authority on the subject of the Lepidoptera of Great Britain, and familiar with its general natural history. Died June 29th, in the sixty-seventh year of his age.

Dufour, General H. W. Well known to geographers from the topographical maps of Switzerland produced under his direction as chief of the Swiss general staff. Died at Geneva about the middle of July.

Findlay, A. G. An eminent geographer and author of many excellent maps and charts. Publisher of sailing directions for various parts of the world, to the amount of over 6000 pages. Born in London, January 6th, 1812. Died at Dover, May 3d, in the sixty-fourth year of his age.

Franklin, Lady. Distinguished as the wife of Sir John Franklin, and the companion of his geographical and other pursuits, from the date of her marriage, November 5th, 1828, until his departure on his last journey in 1845. She was devoted to the effort to secure the relief of or information respecting the fate of her husband even to the time of her own death, and was the only woman besides Mrs. Somerville who enjoyed the distinction of having the gold medal of the Royal Geographical Society conferred upon her. Died July 15th, at the age of eighty-three.

Goodenough, Commodore J. G. A British naval officer and geographer. Born in 1830. Entered the navy in 1844, on the *Collingwood*. Killed by a poisoned arrow while trying to open friendly intercourse with the natives of Santa Cruz Island, August 20th.

Gray, Dr. John Edward. The veteran zoologist of the British Museum, with which he was connected fifty years, and for thirty-five years its keeper.

Author of many voluminous zoological publications, one of the most conspicuous being "The Knowsley Menagerie." Born at Walsall in 1800.

Gurney, Sir Goldsworthy. The inventor of the Bude light, and of applications for ventilating fiery coal-pits and extinguishing fires in them by the steam jet.

Guthe, Hermann. Author of many excellent geographical text-books. Died at Munich, January 29th, 1874, in the fiftieth year of his age.

Hanbury, Daniel. A high authority in the matter of the history and sources of drugs, his "Pharmacographia" being his most important work. Died March 24th, in London, of typhoid fever, at the age of forty-nine.

Hardwicke, Robert. Publisher of many important scientific serial and other works. Died in London, March 8th.

Hays, William J. A prominent American artist, especially skilled in the delineation of wild animals. Died in New York, March 13th, at the age of forty-five.

Head, Sir Francis Bond. A well-known engineer, and at one time Lieutenant-Governor of Upper Canada. Author of several popular works of travel. Died in July, at the age of eighty-two.

Henwood, William J. A zealous investigator in reference to subterranean temperatures, mineral veins, the conducting power of various rocks, etc. Died in Penzance, August 5th, at the age of seventy-one.

Kiernan, Francis. An eminent zoologist and anatomist. An examiner for many years of the Royal College of Surgeons. Died December 31st, 1874, in the seventy-fifth year of his age.

Lankester, Dr. Edwin. One of the originators of the British Association. Editor of the *Quarterly Journal of Microscopical Science.* Publisher of many works on natural history, the best known being his "Half Hours with the Microscope." Born in 1814. Died at Margate, of diabetes, October 30th, in his sixty-first year.

Lapham, Dr. Increase A. Prominent as a naturalist, geologist, surveyor, and meteorologist. Founder of the Wisconsin Academy of Natural Sciences and Arts. Author of an important work upon "The Ancient Monuments of Wisconsin." Discoverer of many new species of shells. Born at Palmyra, N. Y., March 7th, 1811. Died at Milwaukee, September 14th, in the sixty-fifth year of his age.

Le Besque, M. The oldest correspondent of the Geometry Section in the Academy of Sciences of Paris. Died at Bordeaux, June 12th.

Le Font, Alexander de. Director of the Arcachon Museum. Distinguished for important discoveries in practical oyster-culture. Died at the age of forty-five.

Logan, Sir William E. An eminent mining engineer and geologist. Chief of the Geological Survey of Canada from 1842 to 1870. Born at Montreal, where he also died, at the age of seventy-eight, June 28th.

Long, Captain Thomas. The first to establish the existence of a large body of land in the Arctic Ocean north of Behring Strait, and called by him Wrangell Land. Died near Honolulu, August 8th.

Lyell, Sir Charles. A veteran in geological science, of which his works were the chief exponents. Published five editions of a work entitled "Principles of Geology," and several others upon the same science; "The Student's Manual of Geology" being a standard text-book. Also author of an important treatise on the "Geological Evidences of the Antiquity of Man." In recognition of his merits he was made the president and medalist of numerous societies. Born November 14th, 1797. Died February 22d, 1875, in the seventy-ninth year of his age.

Mason, Rev. Francis. Born at York, England. Missionary to Burmah in 1830. Author of many valuable works on that country. Died at Rangoon, March 3d, 1874, at the age of seventy-five.

Mathieu, Professor Claude Louis. Oldest member of the Academy of Sciences of Paris. Author of several scientific and literary works, and known especially in connection with the "Annual of the Bureau des Longitudes." Died March 5th, in the ninety-third year of his age.

Mauch, Dr. Carl. Known as an explorer in Africa. Died April 4th, in consequence of a fall from a window.

Maw, Henry L. The first Englishman to explore the Amazon from its source to its mouth. Born in 1801.

McDonald, Dr. William. Professor of Civil and Natural History for twenty-four years in the United Colleges of St. Andrews. Died January 1st, 1875.

Mohamed, Si Abdallah Ben. An eminent Arabian chemist. Died in Algiers, May 11th, at the age of thirty-two.

New, Charles. A missionary, the first person to ascend the snow-clad mountain of Kilima-njaro. Died during an expedition into the interior of Africa.

Nieto, José A. A member of the Entomological Society of France, and a well-known collector of Mexican insects, especially of Coleoptera. Died at Cordova, Mexico.

Oates, Frank. A recent traveler in Africa. Died of fever near the Makalake towns, February 5th, at the age of thirty-five.

Osborn, Admiral Sherrard. A well-known arctic traveler. A volunteer in the search for Sir John Franklin in the expedition of 1849. Entered the service of the Emperor of China in 1862. Returning to England, engaged in building iron-clad vessels. A zealous friend and promoter of arctic research. Born in 1822. Died in London, May 8th, at the age of fifty-three.

Pease, Charles. An amateur naturalist; obtained the first specimen of *Dendroica kirtlandiæ.* Member of the Western Union Telegraph expedition to the Yukon River in 1865. Died at Cleveland, June 11th.

Peschel, Dr. Oscar. An eminent German geographer. Editor of *Das Ausland* for twenty years. Professor in the University of Leipsic. Author of many geographical works. Died in September at Leipsic.

Plath, Dr. Johann Heinrich. An eminent Chinese scholar. Author of many papers on Oriental subjects. Died November 16th, at Munich, at the age of seventy-three.

Reslhuber, Professor. Director of the observatory at Kremsmunster, in Austria. Died in September, in the sixty-eighth year of his age.

Roberts, Edward. An architect and antiquary. Honorary Secretary of the British Archæological Association. Died in October, in the fifty-seventh year of his age.

Roome, James H. A taxidermist and collector of objects of natural history. Died in New York, January 20th, at the age of sixty-five.

Scherer, Carl J. A. T. A well-known mineralogist and metallurgist. Author of many memoirs on chemistry, mineralogy, and geology, as well as upon iron-smelting and the blowpipe. Died at Freiburg, August 20th, at the age of about sixty-two.

Schott, Dr. Arthur. A zealous explorer, especially in Texas, Mexico, and Yucatan, and the Isthmus of Darien, and collector of objects of natural history, and the discoverer of many new species of animals and plants. Died at Georgetown, District of Columbia, July 26th, in the sixty-seventh year of his age.

Schrötter, Professor A. Perpetual Secretary of the Academy of Sciences of Vienna, and Master of the Mint. Author of many important chemical discoveries. Died April 15th, at the age of seventy-three.

Schwabe, H. H. Noted formerly for astronomical researches. Discoverer of the periodicity of the solar spots. Died at Dessau, April 11th, in the eighty-fifth year of his age.

Seguin, Sen., M. Correspondent in the section of Mechanics in the Academy of Sciences of Paris. Died at Annonay, February 24th, in the eighty-ninth year of his age.

Silveria, Conseiller Joaquim Henriques Tradessá Da. Director of the Meteorological Observatory at Lisbon. Died May 21st.

Smirke, Sir E. Distinguished for his knowledge of manorial and territorial rights and customs.

Sundevall, Professor Carl J. Distinguished as an explorer and a naturalist. Author of numerous zoological works. Curator of the National Museum at Stockholm. Born in 1801. Died at the age of seventy-four.

Thuret, M. An eminent French botanist, and a voluminous writer, especially upon the physiology and reproduction of the algæ. Died May 10th.

Tillman, Professor Samuel D. A zealous student of physical and experimental science. A member and officer of the American Institute of New York. Died September 4th, at the age of seventy-two.

Timbs, John. Editor of "The Year-Book of Facts." Died in London, in March, at an advanced age.

Waldeck, Baron J. F. de. A well-known traveler in Africa and America, and distinguished as an artist. Born in Prague; died in Paris, April 30th, at the age of *one hundred and nine!*

Walker, Francis. An eminent entomologist, long connected with the British Museum. Author of several works upon the diptera, etc. Died October 5th.

Webster, Thomas. An eminent patent lawyer of London. Died June 3d, in the sixty-fifth year of his age.

Wheatstone, Sir Charles. Professor of Experimental Philosophy in King's College, London. Discoverer of important practical applications in electrical science. Born in 1802. Died October 20th.

Willis, Professor R. Known as filling the chair of Jackson Professor at Cambridge, England. Died early in March.

Wilson, William Parkinson. Professor of Mathematics in Melbourne University, at which place he died, December 11th, 1874.

Winlock, Professor Joseph. Director of the observatory of Harvard College. Distinguished as an astronomer, and as an inventor of devices for improving the methods and qualities of astronomical manipulation. Died June 11th, at the age of forty-nine.

Zetterstedt, Professor Johann Wilhelm. An eminent Swedish entomologist, for many years Professor of Natural History at Lund. Died at Stockholm.

Q. BIBLIOGRAPHY.

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The following list of books relating to the several departments of science contains only the smaller portion of those published during the past year, but, it is believed, embraces the most important. The limitations of the *Record* preclude an exhaustive bibliographical enumeration or plan; nor, indeed, is this required by readers. Works only have been introduced that have features of general interest to commend them, especially such as have been more or less favorably noticed in the principal journals devoted to general science, and mention will be found of the places in the several journals where criticisms are contained. These references will serve in lieu of the critical notices which were proposed in the previous volume for the present *Record;* experience having shown that, in order to do justice to the several works and to ourselves, more space would be required than could be well spared for the purpose.

Whenever the volumes themselves were accessible, the titles and collations have been taken directly from them. In many cases, however, the compiler has been obliged to depend solely on the titles contained in the journals in which the volumes have been noticed, or upon booksellers' announcements. All the scientific works sent to the editor of the *Record* have been, and will hereafter be enumerated, whether specially noticed in the journals in question or not. The responses to the invitation for the transmission of copies to the editor for notice have been numerous, but many important publications have been withheld. In the interest of accuracy and completeness of enumeration, the editor renews his request for copies of new works for notice in future numbers of the *Record's* Bibliography.

For the notices of books, those journals have been referred to which are most generally accessible to ordinary readers on account of the nature of their circulation. They are:

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(3.) Nature: a Weekly Illustrated Journal of Science. London.

(4.) The Popular Science Monthly. Conducted by E. L. Youmans. Vol. VI. November, 1874, to April, 1875 (etc.). New York: D. Appleton and Company, 549 and 551 Broadway. 1875. (Published monthly, at $5 per annum.)

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(Dominion of Canada.)

Dawson (G. M.). Report on the Geology and Resources of the Region in the Vicinity of the 49th Parallel from the Lake of the Woods to the Rocky Mountains. By G. M. Dawson, Geologist and Botanist to the Commission. Montreal. 1875. (8vo, 388 pp., with a Colored Geological Map, Views, and Sections.) Addressed to Mayor D. R. Cameron, R.A., H. M. Boundary Commissioner.
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[Am. Journ. S. and A. (3), X., 392, 1875.]

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[Am. Journ. S. and A. (3), IX., 400, 401, 1875.]
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[Nature, XIII., 23, 24, 1875.]

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[Am. Journ. S. and A. (3), X., 400, 1875.]

Jones (Wm. A.). Report upon the Reconnaissance of Northwestern Wyoming, including Yellowstone National Park, made in the Summer of

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[Am. Journ. S. and A. (3), X., 303, 304, 1875.]

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[Nature, XI., 322–324, 1875.]

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Mundy (D. L.). Rotomahana and the Boiling Springs of New Zealand. A Photographic Series of Sixteen Views. With Descriptive Notes by Ferdinand von Hochstetter, Professor of the Polytechnic Institution of Vienna. London: Sampson Low & Co. 1875.
[Nature, XII., 532, 1875.]

R. INDEX TO THE REFERENCES.

In the large number of serial works received regularly for use in the preparation of material for the *Record*, it has been found expedient to adopt some mode of abbreviating the titles, so as to save both time and space in writing and printing them. For this purpose the different countries have been represented by letters, and the journals numbered as in the following table. Publications referred to only occasionally are indicated by abbreviations of their titles at the ends of the articles. Where no references are made, it is to be understood that the article is partially or entirely original, and prepared by the editor or his collaborators; in some cases, however, that the quotation has been mislaid or overlooked.

The list of works here mentioned relates simply to those most frequently consulted—especially those coming direct through the post-office—and forms but a small portion of those passed regularly in review. The Smithsonian Institution is in regular and constant receipt of the latest publications from at least one thousand societies and establishments, public and private, in different parts of the world, and its unrivaled scientific library is used to a greater or less extent by the editor and his associates in the preparation of the *Annual Record*.

A. *Great Britain.*

1. The Chemical News and Journal of Physical Science. Weekly. London.
2. Land and Water. Hunting, Shooting, Fishing, practical Natural History. Weekly. London.
3. Iron: the Journal of Science, Metals, and Manufactures: with which is incorporated the Mechanics' Magazine, established 1823. Weekly. London.
4. Hardwicke's Science Gossip. Monthly. London.
5. The Popular Science Review. Quarterly. London.
6. The Geographical Magazine (late Ocean Highways). Monthly. London.
7. London, Edinburgh, and Dublin Philosophical Magazine. Monthly. London.
8. Scientific Review: Record of progress in Arts, Industry, and Manufactures; and Journal of the Inventors' Institute. Monthly. London.

10. The Annals and Magazine of Natural History. Monthly. London.

11. Proceedings of the Scientific Meetings of the Zoological Society of London. London.

12. Nature: a weekly illustrated Journal of Science. London.

13. The Academy: a weekly review of Literature, Science, and Art. London.

14. The Pharmaceutical Journal and Transactions of the Pharmaceutical Society. Weekly. London.

15. The Athenæum: Journal of English and Foreign Literature, Science, and Fine Arts, Music, and the Drama. Weekly. London.

16. The Quarterly Journal of Science, and Annals of Mining, Metallurgy, Engineering, Industrial Arts, Manufactures, and Technology. London.

17. The Journal of Applied Science: a monthly record of progress in the Industrial Arts. London.

18. English Mechanic and World of Science. With which are incorporated "The Mechanic," "Scientific Opinion," and the "British and Foreign Mechanic." Weekly. London.

19. The Field, the Farm, the Garden: the Country Gentleman's Newspaper. Folio. Weekly. London.

20. Medical Times and Gazette. Weekly. London.

21. Journal of the Chemical Society, containing the papers read before the Society, and abstracts of chemical papers published in other journals. Monthly. London.

22. Illustrated London News. Weekly. London.

23. Journal of the Society of Arts. Weekly. London.

24. The Telegraphic Journal, and Electrical Review. Weekly. London.

25. The Electrical News and Telegraphic Reporter. Weekly. London.

B. *France.*

1. Bulletin hebdomadaire de l'Association Scientifique de France. Weekly. Paris.

3. Les Mondes: revue hebdomadaire des Sciences et de leurs applications aux Arts et a l'Industrie. Weekly. Paris.

4. Le Moniteur Scientifique du Dr. Quesneville. Journal des Sciences pures et appliquées. Bi-monthly. Paris.

5. Le Technologiste, ou Archives des progrés de l'industrie française et étrangère. Monthly. Paris.

6. Comptes rendus hebdomadaires des séances de l'Académie des Sciences. Weekly. Paris.

8. Revue Scientifique. Weekly. Paris.

9. Revue hebdomadaire de Chimie scientifique et industrielle publiée sous la direction M. Ch. Mène. Weekly. Paris.

10. Bulletin Mensuel de la Société d'Acclimatation. Monthly. Paris.

11. Revue de Therapeutique Medico-chirurgicale. Bi-monthly. Paris.

12. Bulletin général de Therapeutique médicale et chirurgicale. Bimonthly. Paris.

13. La Nature. Weekly. Paris.

14. Journal de Zoologie. Paul Gervais. Bi-monthly. Paris.

15. Annales des Sciences Naturelles: zoologie et paléontologie. Milne-Edwards. Occasional. Paris.

16. Revue et Magasin de Zoologie pure et appliquée. Monthly. Paris.

17. Archives de Zoologie experimentale et générale. H. Lacaze-Duthiers. Quarterly. Paris.

18. Annales des Sciences geologiques. Hébert and Alphonse Milne-Edwards. Occasional. Paris.

19. La Chasse Illustrée. A. Didot. Weekly. Paris.

20. Materiaux pour l'histoire primitive et naturelle de l'homme. Monthly. Octavo. Toulouse.

21. Revue d'Anthropologie de M. Paul Broca. Quarterly. Octavo. Paris.

C. *Germany and Austria.*

1. Aus der Natur. Die neuesten Entdeckungen auf dem Gebiete der Naturwissenschaften. Weekly. Leipsic.

2. Archiv der Pharmacie. Monthly. Halle.

3. Das Ausland. Ueberschau der neuesten Forschungen auf dem Gebiete der Natur- Erd- und Völkerkunde. Weekly. Augsburg.

4. Badische Gewerbezeitung für Haus und Familie. Monthly. Karlsruhe.

5. Deutsche illustrirte Gewerbezeitung. Weekly. Berlin.

6. Deutsche Industrie-Zeitung: Organ der Handels- und Gewerbekammern zu Chemnitz, etc. Weekly. Dresden.

7. Gaea. Natur und Leben. Zeitschrift zur Verbreitung und Hebung naturwissenschaftlicher, geographischer, und technischer Kenntnisse. Monthly. Köln and Leipsic.

8. Industrie-Blätter: Wochenschrift für Fortschritt und Aufklärung in Gewerbe, Hauswirthschaft, Gesundheitspflege, etc. Weekly. Berlin.

9. Kurze Berichte über die neuesten Erfindungen, Entdeckungen und Verbesserungen im Gebiete des Gewerbwesens, des Handels und der Landwirthschaft. Monthly. Mannheim.

10. Landwirthschaft und Industrie; Monatsschrift für Landwirthe, Fabrikanten und Geschäftsleute jeder Art. Monthly. Berlin.

11. Die neuesten Erfindungen im Gebiete der Landwirthschaft, des Bergbaues, des Fabrik und Gewerbwesens und des Handels. Illustrirte Zeitschrift. Semi-monthly. Vienna.

12. Oberlausitzer Gewerbeblatt. Organ der Gewerbe- und Handwerker-Vereine des Königreichs Sachsen. Semi-monthly. Bautzen.

13. Polytechnisches Central-Blatt. Semi-monthly. Leipsic.

14. Polytechnisches Journal, etc. Dr. E. M. Dingler. Semi-monthly. Augsburg.

15. Polytechnisches Notizblatt für Gewerbtreibende Fabrikanten und Künstler. Bi-monthly. Mainz.

16. Blätter für Gewerbe, Technik, und Industrie. Leipsic.

17. Mittheilungen aus Justus Perthes geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie. Dr. A. Petermann. Monthly. Gotha.

18. Chemisches Central-Blatt. Repertorium für reine, pharmaceutische, physiologische, und technische Chemie. Weekly. Leipsic.

19. Der Naturforscher. Wochenblatt zur Verbreitung der Fortschritte in den Naturwissenschaften. Weekly. Berlin.

21. Neues Jahrbuch für Pharmacie. Monthly. Heidelberg.

22. Landwirthschaftliches Central-Blatt für Deutschland. Monthly. Berlin.

23. Das Deutsche Wollen-Gewerbe. Organ für die Wollen-Waaren-Industrie, etc. Weekly. Grünberg.

24. Färber-Zeitung. Organ für Färberei, Druckerei, Bleicherei, Appretur, etc. Dr. N. Reimann. Weekly. Berlin.

25. Muster-Zeitung. Zeitschrift für Färberei, Druckerei, Bleicherei, Appretur, etc. Dr. F. Springmühl. Weekly. Berlin.

26. Deutsche Färber-Zeitung. J. C. H. Geyer. Bi-monthly. Mühlhausen.

27. Preussisches Handelsarchiv. Wochenschrift für Handel, Gewerbe und Verkehrs-Anstalten. Weekly. Berlin.

28. Central-Blatt für Agrikulturchemie und rationellen Wirthschaftsbetrieb. Monthly. Leipsic.

29. Bayerisches Industrie und Gewerbeblatt. Monthly. Munich.

30. Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte. Monthly. Braunschweig.

31. Mittheilungen der Anthropologischen Gesellschaft in Wien. 8vo. Vienna.

32. Allgemeine deutsche Polytechnische Zeitung. Herausgegeben von Dr. H. Grothe. Weekly. Berlin.

33. Annalen der Chemie und Pharmacie. Herausgegeben von F. Wöhler, J. Liebig, H. Kopp, E. Erlenmeyer, J. Volhard. Monthly. Leipsic and Heidelberg.

34. Neue deutsche Gewerbe-Zeitung. Bi-monthly. Leipsic.

35. Berichte der deutschen chemischen Gesellschaft zu Berlin. About Monthly. Berlin.

36. Zeitschrift für Wissenschaftliche Zoologie. Siebold & Kölliker. Occasional. Leipsic.

37. Repertorium der Naturwissenschaften. Monatliche Uebersicht der neuesten Arbeiten auf dem Gebiete der Naturwissenschaften. Monthly. Berlin.

D. *America.*

1. Journal of the Franklin Institute, devoted to Science and the Mechanic Arts. Monthly. Philadelphia.

2. Proceedings of the Academy of Natural Sciences of Philadelphia. Monthly. Philadelphia.

3. Proceedings of the Boston Society of Natural History. Quarterly. Boston.

4. The American Journal of Science and Art. Silliman and Dana. Monthly. New Haven, Ct.

5. The American Naturalist: a popular illustrated Magazine of Natural History. Monthly. Salem, Mass.

6. Scientific American: a weekly journal of practical information in Art, Science, Mechanics, Chemistry, and Manufactures. New York.

7. The American Chemist. Monthly. New York.

8. Journal of Applied Chemistry. Monthly. New York.

10. The Rod and Gun: late American Sportsman. Weekly. West Meriden, Ct., and New York.
11. Forest and Stream. Weekly. New York.
12. The Spirit of the Times. Weekly. New York.
13. The Popular Science Monthly. New York.
15. Turf, Field, and Farm. Weekly. New York.
16. Field and Stream. Weekly. Chicago.
17. The Engineering and Mining Journal. Weekly. New York.
18. Live Stock Journal. Monthly. New York and Buffalo.
19. The Poultry World. Monthly. Hartford.
20. The Iron Age. Weekly. New York.
21. The Railroad Gazette. Weekly. New York.
22. The Metal Worker. Weekly. New York.

E. *Netherlands.*

1. Archives néerlandaises des Sciences exactes et naturelles publiées par la Société hollandaise des Sciences a Harlem. Occasionally. La Haye.

F. *Switzerland.*

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G. *Italy.*

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H. *Denmark.*

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[The Roman Letters refer to the Summary at the beginning of the Volume.]

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ANNUAL RECORD

OF

SCIENCE AND INDUSTRY

FOR 1876.

EDITED BY

SPENCER F. BAIRD,

WITH THE ASSISTANCE OF EMINENT MEN OF SCIENCE.

NEW YORK:
HARPER & BROTHERS, PUBLISHERS,
FRANKLIN SQUARE.
1877.

PREFACE.

THE present volume of the "Annual Record of Science and Industry" constitutes the sixth of the series, and is intended to present an intelligible and popular account of the more important facts of progress in the various departments of the physical and natural sciences, and their applications to the conveniences and luxuries of mankind.

Its distinguishing features, as compared with other works intended to answer the same general purpose, are as follows:

First, a series of summaries of progress in the different branches of physical, natural, and industrial science, prepared by a number of the most eminent specialists in the United States, whose collaboration the editor has been so fortunate as to secure.

Second, a series of abstracts, more or less systematically arranged, of special papers, memoirs, or other publications, by various writers, and with references to the title, volume, and page of the source of information; these abstracts very rarely being transcripts from the original, but digests in which only the points of special novelty and interest are presented, with omission of irrelevant matter, and not unfrequently with critical remarks and elucidations. These have been for the most part edited and prepared by the specialists referred to.

Third, a list of the losses in scientific circles by death during the year.

Fourth, a list of the more important publications in science for the year embraced within the scope of the *Record*, with references to critical notices, serving as a guide to students and purchasers of books. In connection

with this is a list of the principal serial works from which extracts or quotations are to be found in the volume.

Fifth, an extremely minute alphabetical index of authors and subjects.

Sixth, a systematic and analytical table of contents, by means of which reference can readily be made to whatever the volume contains, bearing upon any particular line of inquiry.

Seventh, in compliance with a generally expressed wish, the names of the authors of the different portions of the Scientific Summary are given for the first time in the present volume of the *Record*, in connection with their respective communications, all of them men occupying the front rank in America as authors and investigators. Other collaborators not contributors to the first division of the volume are Professor C. F. Himes, of Dickinson College, Carlisle, Pa.; Professor F. W. Clarke, of the University of Cincinnati; Professor E. D. Cope, of Philadelphia; Professor F. V. Hayden; Major J. W. Powell; Lieutenant George M. Wheeler, U. S. A., and several others who prefer to remain unmentioned.

It will be readily understood that the present volume is prepared for the general public, who desire to become acquainted with the more prominent steps of advancement during the year, without the trouble of resorting to the sources of original information concerning the same. Specialists may find little or nothing in it to merit their attention, and, indeed, they may naturally be inclined to criticise the work for not being more complete. It must be borne in mind, however, that the work is limited in extent, and that, in view of the enormous subdivision of labor at present in the line of scientific investigation, any attempt at exhaustiveness would involve a vast increase in the size of the book. At the present time there is scarcely a branch of science which is without one or more journals as its organs and an annual record devoted exclusively to its history; and to these reference should be made for more minute information. It is hoped, however, that but little of general or popular interest has been overlooked.

In the selection for the Scientific Bibliography the editor has been chiefly guided by the commendatory notices which have appeared in the more prominent scientific journals of the day, and references to the pages of the journals wherein the works catalogued and reviewed are given. As the journals in question are generally easily accessible, the reader is thus furnished with a trustworthy guide in his selection of books.

SPENCER F. BAIRD.

SMITHSONIAN INSTITUTION, WASHINGTON, *March* 1, 1877.

PART II.

ABSTRACTS OF SCIENTIFIC AND INDUSTRIAL ARTICLES.*

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* In the arrangement of articles in the body of the *Record*, it was found impracticable to place them in proper systematic sequence, especially as many belonged as much to one division as to another, sometimes even to three or four equally. The present systematic Table is intended to remedy the difficulty, by bringing together in proper order all the titles of articles, and, by a system of cross references and duplications, to point out all matter relating to any one subject, whatever be its situation in the volume. The references in Roman letters preceding the page references of the headings relate to the pages of the introductory "Summary."

GENERAL SUMMARY

OF

SCIENTIFIC AND INDUSTRIAL PROGRESS

DURING THE YEAR 1876.

ASTRONOMY.

BY EDWARD S. HOLDEN,

PROFESSOR OF MATHEMATICS, UNITED STATES NAVY.

INTRODUCTION.

IN presenting a review of the progress of Astronomy during the past year, it is to be remembered that the principal results reached are such as can be readily classified under appropriate heads, and there are but few in this year, as in every year, which call for especial and peculiar mention. The successful application of photography to the registration of star spectra by Huggins and Draper, however, constitutes a most important step in the progress of stellar physics. Many publications of standard value have been made, such as the "Observations of the Zodiacal Light," by Heis; the "General Catalogue of Double Stars," by Burnham; the zones of nebulæ observed by Vogel at Leipzig; Langley's and Spoerer's solar investigations, and many others. A most striking advance is the growing tendency of astronomers to an economical division of labor, as, for example, in the prosecution of the zones of the German Astronomical Society; in the computation of comet orbits under the auspices of the same society, etc. A praiseworthy example of co-operation is shown by the Italian observatories, which have divided the field of work according to plans originally devised by Tacchini. By a loyal and zealous co-operation, the whole energy of the astronomers of Italy is judiciously applied to the subjects of work in hand, so that each observatory has its especial field, and contributes its full share to the general progress.

The true progress of observational astronomy is to be forwarded by the faithful carrying out of well-devised plans. The number of

such concerted and systematically carried-out schemes of observation is now very great, and extends to all branches of the subject, from the spectroscopic observations of solar phenomena to the meridian observations of asteroids at Greenwich and Paris, and similar work elsewhere. While the present instruments are utilized, new observatories are being founded; and, in particular, many large telescopes are building or newly completed. The history of astronomy has been well exemplified in the interesting Loan Collection at South Kensington; and the republication of the works of Bessel and others is of more than passing importance, and it is to be hoped that these may lead to a collection of the works of the elder Herschel, which is so much needed. Discoveries of new minor planets have ceased to be the novelty they were in 1801, owing to the assiduity of astronomers. The intra-Mercurial planet has so far not been detected, although patiently sought for. With this brief preface, we may proceed to a systematic though condensed view of the work of the present year.

NEW OBSERVATORIES FOUNDED, ETC.

The new *Astrophysikalischen Institut* of Potsdam, under the charge of Spörer, is still in process of building, as well as the Physical Observatory at Paris, under Janssen. Mouchez has established a school of Practical Astronomy and an observatory at Montsouris. The new National Observatory of Austro-Hungary at Vienna, an institution of the first class, is to be completed in 1877. The Savilian Observatory for Celestial Physics at Oxford has also commenced its operations. An observatory for spectroscopic observations of the sun has been founded at Calcutta. The Observatory of Lisbon is to undertake photographic researches.

Little has been done toward the carrying out of the provisions of Mr. Lick's trust for the erection of an astronomical observatory in California. It is to be hoped that this valuable gift to Astronomy will soon begin to yield results. The observatory at Glasgow, Missouri, is completed and partially equipped, and has begun work by a series of observations on Saturn's satellites. One of the most important steps of the year has been in the division of labor adopted among the Italian observatories.

The Royal Observatory at Greenwich has seriously entered into a new field, that of celestial physics. Spectroscopic and photographic work is constantly done. The observatory at Melbourne has received considerable accessions to its instrumental outfit, and is making important contributions to the astronomy of the southern hemisphere in several fields.

The National Observatory at Paris has mounted its four-foot reflector during the year. The mounting is said to be satisfactory, but the mirror is not yet in perfect condition, and the glass for a new

one has been ordered. The Foucault reflector of thirty-one inches aperture has been mounted at Toulouse since February, and Tisserand has begun a study of the Orion nebula and of the fainter satellite systems. The instruments for the Strasburg Observatory are well-nigh completed, and we may look for important work on comets and nebulæ from its accomplished director. Its outfit will be most complete, no pains having been spared in the design and in the execution of the various instruments. Dr. Valentiner, of Leyden, is transferred to Mannheim *vice* Schönfeld, who succeeds Argelander at Bonn. Krüger, of Helsingfors, has succeeded Hansen at Gotha.

Stone, of Washington, has been appointed to be Director of the Cincinnati Observatory, and the Dudley Observatory of Albany is now opened under the charge of Mr. Lewis Boss. Professor Pickering, formerly of the Massachusetts Institute of Technology, has been appointed to be Director of the Observatory of Harvard College. The Observatory of Cordova has completed its zone observations, and is proceeding with the publication of its uranometry.

THE SUN.

Powalky has published an important paper on the Dorpat observations of the sun, 1823–1839.

The solar protuberances are daily mapped by Tacchini, of Palermo, and Secchi at Rome; at Greenwich, by Christie and Maunder; and by various other observers.

Daily photographs are taken at Greenwich, at Paris (by Cornu at the observatory, and by Janssen), Moscow, Toulouse, Kasan, etc.; also by Lockyer, at South Kensington, with a Huyghens lens of 123 feet focus. The spots are observed daily at Madrid, Oxford, Berlin, Zurich, etc. Melbourne also takes daily photographs.

The Royal Astronomical Society has recently acquired an eleven-year series of sun-photographs made by Professor Selwyn.

Secchi has recently brought out a second and greatly enlarged edition of his treatise on the sun. The journal of the Spectroscopic Society of Italy continues its *résumés* of spectroscopic and other work; and its pages may be consulted for special memoirs on spectroscopy. Lockyer, Abney, Roscoe, Stewart, and Vogel are still occupied with their normal map of the solar spectrum; and Draper is pursuing his investigation of metallic spectra. The third volume of the Bothkamp observations, by Dr. O. Löhse, is devoted almost entirely to the discussion of his own solar observations.

Young has recently taken up an important research on the rotation of the solar surface as derived from spectroscopic observations. His observations give for the velocity of the sun's rotation 1.42 miles per second, while direct observation gives 1.25 miles. Vogel's earlier results gave from 1.62 to 1.94 miles. The difference

between Young's result and that given by direct observation is supposed by him to have a possible physical interpretation, viz., that the solar atmosphere really sweeps forward over the underlying surface. The results obtained by Christie at Greenwich are not yet printed, although they have been presented to the Royal Astronomical Society.

The simple arrangement proposed by Hastings some years ago for a comparison of the two limbs of the sun has not, we believe, been applied to this research, for which it seems to be peculiarly fitted.

Langley has continued his observations of solar phenomena, particularly with reference to the heat of various portions of the sun, of sun-spots, etc., and of the effect of sun-spots on terrestrial temperature. In a recent experiment, the light of the sun was compared with that of the molten iron of a Bessemer converter, and the conclusion reached that the temperature of the sun is really far above any temperature observable on the earth, being probably expressed by millions of degrees.

SOLAR ECLIPSES.

Vol. XLII. of the *Memoirs of the Royal Astronomical Society* contains Tennant's report on the total eclipse of 1871, December 11, and Stone's on that of 1874, April 16. Stone's is particularly noticeable, as he has clearly proved the outer corona to be a solar appendage. In this connection Young's discovery of the duplicity of 1474 K is noteworthy, as well as the admirable device by which the discovery was made.

Vol. XLI. of the *Memoirs of the Royal Astronomical Society* contains a discussion, by Ranyard, of the phenomena of recent solar eclipses, which is intended to be exhaustive.

A very interesting daguerreotype of the solar eclipse of 1851, taken at Königsberg, is shown at the Loan Collection at South Kensington. It is, we believe, the first photographic image of the corona, and has been little known until its exhibition at London.

The transit of Venus reductions are not yet completed on the part of any country. Attempts to observe the velocity of light experimentally (and hence the distance of the sun) are to be made by Newcomb, of Washington, in concert with Barker, of Philadelphia, and by Forbes, of Edinburgh.

Lindsay and Gill will shortly publish their value of the solar parallax from observations of Juno. The method has been perfectly successful.

THE MOON.

In the Lunar Theory, Airy continues his researches at Greenwich, as does likewise Newcomb at Washington. Stockwell is oc-

cupied with the development of his new views on the theory. Schjellerup has also given the subject some attention, his only published work being, however, a reply to Stockwell's pamphlet. A new lunar inequality has been detected by Newcomb.

Lohrmann's map of the moon is now to be completely published under the editorship of Schmidt, who is also publishing his own great chart. Tempel is likewise engaged on a map of the moon.

Neison has embodied his work on the moon's atmosphere, physical features, etc., into an octavo book lately published.

Work on the British Association chart of the moon (Birt's) is, we believe, temporarily suspended for want of funds.

It is understood that the attraction-meter devised by Dr. C. W. Siemens, and exhibited by him at South Kensington, is soon to be applied by Sir William Thompson to determine the mass of the moon.

THE PLANETS AND SATELLITES.

Drawings of Mars continue to be made by Terby and others. Trouvelot, of Cambridge, has made one hundred and twenty-five drawings of Jupiter during the present opposition—a very important work, as the planet was too low for observation in Europe. Trouvelot confirms the statement of Löhse that changes of unusual magnitude are this year occurring on Jupiter. He also has published a drawing of Saturn, with a discussion of its physical features, in which some new views of the shape of the rings are advocated. Weber's supposed observation of Vulcan, on April 4th, 1876, has led, by request of Le Verrier, to a general examination of the sun, on October 2d and 3d, and 9th and 10th, with the object of detecting this planet in transit. This search was unsuccessful.

Janssen has devised an apparatus by means of which a photograph of the sun may be automatically taken every quarter of an hour, and this he proposes to erect at Paris, for the purpose of detecting interior planets in transit. The whole question of the existence of a planet interior to Mercury (Vulcan) has been carefully examined in a series of memoirs by Le Verrier, abstracts of which are given in the following pages. His general conclusion is that in 1885 a transit of Vulcan will take place, and to that time he defers the definite answer to the question of Vulcan's existence.

It has been pointed out, however, that in 1878 a very favorable total solar eclipse occurs in America, and with proper care such a body as Vulcan is supposed to be can hardly escape detection if especial attention is directed to it.

Following is a list of the minor planets discovered during the year:

MINOR PLANETS.

Number.	Name.	Date of Discovery.	Approximate Magnitude.	Discoverer.	Observatory.
		1876.			
158	Koronia,	Jan. 4,	11.12	Knorre,	Berlin.
159	Emelia,	Jan. 26,	12.5	Paul Henry,	Paris.
160	Una,	Feb. 25,	11	C. H. F. Peters,	Clinton.
161	Alhor,	April 19,	11	Watson,	Ann Arbor.
162	?	April 22,	12	Prosper Henry,	Paris.
163	Erigone,	April 28,	12	Perrotin,	Toulouse.
164	Eva	July 12,	12.5	Paul Henry,	Paris.
165	Loreley,	Aug. 9,	10.7	C. H. F. Peters,	Clinton.
166	Rhodope,	Aug. 10,	11.2	C. H. F. Peters,	Clinton.
167	Urda,	Aug. 28,	12	C. H. F. Peters,	Clinton.
168	Sybilla,	Sept. 28,	11	Watson,	Ann Arbor.
169	Zelia	Sept. 28,	11	Prosper Henry,	Paris.

Palisa, of Pola, has likewise rediscovered *Maia* (66), which has been lost for some time.

Le Verrier has published, or shortly will publish, tables of Jupiter, Saturn, Uranus, and Neptune. Other occupations have hindered Mr. George W. Hill in the preparation of his tables of Saturn.

The theory of the satellites of Jupiter has been investigated by Souillart, who is preparing tables of their motion. Todd, of Washington, has extended the tables of Jupiter's satellites to 1900, and the American ephemeris will publish the tables. Newcomb has published tables of the motion of the satellites of Uranus and Neptune. A great number of observations of the satellites of Saturn has been made by Hall at Washington, and at Greenwich, and Glasgow, Missouri, observations have been made, aided by the valuable ephemeris of Marth. The Washington observers have also made a number of observations of the satellites of Uranus and Neptune. Hall has discovered a white spot on Saturn which has been followed through over sixty revolutions, and the observations of which give a rotation time of $10^h\ 14^m\ 23.8^s \pm 2.3^s$. The Observatory of Leyden has become possessed of Schroeter's unpublished work on Mars.

COMETS.

There has been no discovery of a comet during the year.

Bredichin, of Moscow, has published an important memoir on the phenomena of the tail of Comet III., 1862. Kowalczyk, of Warsaw, has published a definitive orbit of Comet II., 1840. It is an ellipse of about 3700 years' period. Weiss, of Vienna, in investigating the orbit of the comet of Coggia (November, 1873), concludes it to have a period of 6.20 years, and to be identical with that of Pons (1818). Tuttle's periodic comet will reappear in 1884, and the preparation

of an ephemeris, and a discussion of its elements, is under the charge of Professor O. Stone, of the Cincinnati Observatory.

MOTIONS OF STARS TOWARD OR FROM THE EARTH.

The theoretical basis upon which rest the recent determinations of the motions of stars in the line of sight, by means of the spectroscope, has been called in question by Van der Willigen, in a mathematical memoir published some years ago. During the past year Secchi has undertaken to repeat certain measures of Huggins upon several of the brighter stars, and he has found that in his own observations constant errors arose, which masked the true deviations of the stellar lines from their corresponding lines in the comparison spectra. On examining the results obtained by himself, Huggins, Christie, and Vogel, he came to the conclusion that these showed a strong probability that the determinations were affected with constant errors. This was particularly so in the case of Greenwich, nearly all of the results obtained at this observatory showing a motion of the star *toward* the earth. Since the publication of this paper, Christie, of Greenwich, has published a new set of measures, which, in the main, corroborate Huggins's previous determinations; and Huggins has replied to some strictures by Secchi in a note which describes the delicacy of the research, and states that the difficulties Secchi encountered must be overcome before any trustworthy results are possible, and that Huggins himself had successfully avoided these drawbacks. Since the above paragraph was in type, Huggins has communicated to the Royal Society, and Draper to *Silliman's Journal*, accounts of the successful application of photography to the registration of stellar spectra.

SOLAR MOTION IN SPACE.

Safford has recently taken up anew the investigation of this question, using for the purpose Argelander's 250 stars.

In studying these stars, Professor Safford grouped them by tens, assuming those to be equally distant whose proper motions in arc were nearly equal, and therefore leaving entirely out of consideration the brightness of the stars. His first result, as regards the direction of the movement of the solar system, was not very different from those of his predecessors; but there appeared indications that, for each of his groups of stars, the average proper motion was inversely proportional to the average distance; in other words, that our assumption of stellar distances ought to depend upon proper motions. He concludes that the stars having similar motions especially need study at this time, and that eventually we may hope to use the solar motion as a sort of base to advance our knowledge of stellar distances.

NEBULÆ.

Winnecke, of Strasburg, has begun work again in this field with powerful instruments. Bruhns has begun the publication of charts of nebulæ observed in zones at Leipzig. Vogel has published the results of a determination of the positions of all the nebulæ in the Leipzig zone of the new *Durchmusterung.* It takes its place at once with the works of Auwers, Schönfeld, and Schultz, and Vogel's former work of 1867, as an acknowledged classic. Vogel has also made some drawings of hitherto unpublished nebulæ. Forty or fifty southern nebulæ, formerly figured by Herschel, have been drawn and studied by Ellery, of Melbourne, and his assistants, and the results will shortly be published. Gould, of Cordoba, has made many photographs of southern clusters and double stars. A monograph of the ring nebula of Lyra has been published by Holden, of Washington, as well as a detailed discussion of all published drawings and observations of the nebula G. C. 4403, in which it is endeavored to show a veritable proper motion to this body. Tisserand, of Toulouse, and Tempel, of Florence, as well as Holden at Washington and Trouvelot at Cambridge, have published preliminary results of their work on the Orion nebula. Bredichin, of Moscow, has investigated the spectra of many planetary nebulæ, and finds them in general to be of one type, and usually to be sensibly the same. Dreyer, of Parsonstown, is preparing a supplement to Herschel's general catalogue.

DOUBLE STARS.

Double stars have been faithfully observed during the past year, the most noteworthy publications of private observers being those of Dembowski, Gledhill and Crossley, Wilson and Seabroke, and Barclay.

Otto Struve at Pulkova, Dembowski at Gallarate, Dunér at Lund, Newcomb and Hall at Washington, Wilson and Seabroke, of Rugby, Crossley and Gledhill, of Halifax, and others, have published important measures of difficult stars. Burnham, of Chicago, and Howe, of Cincinnati, have published lists of new double stars. A method for obtaining the relative personal equation of various double-star observers by simultaneous observations of a selected list of doubles is proposed by Struve, and will be followed by several observers.

The double-star observations and discoveries of O. M. Mitchel have been prepared for the press by the present Director of the Cincinnati Observatory, Professor Ormond Stone, and will shortly be issued.

The supposed discovery of a companion of Procyon in 1873, and the subsequent observations of 1874 by Otto Struve, are now sup-

posed by him to have been deceptions. The companion demanded by Auwers' theory has thus far not been detected.

BINARY STARS.

Doberck, of Markree, has taken up the subject of the computation of binary star orbits with much zeal, and to him we owe many publications on this subject. Tisserand, Schiaparelli, and others have contributed to this subject important papers.

A work by Crossley, Wilson, Gledhill, and Doberck, jointly, is in course of preparation on the general subject of double and binary stars, their observation, history, orbits, etc. Lord Lindsay has prepared for publication an index to W. Struve's double-star observations. Of particular binaries, one of the most noteworthy is *Beta Leporis*, discovered by Burnham (distance about three seconds of arc), which has a motion of about 2° a month in position angle. This indicates this star as probably one of the nearer stars, and makes an investigation of its parallax desirable by some southern observatory.

ZODIACAL LIGHT, METEORITES, VARIABLE STARS, ETC.

The observations of J. C. Houzeau, of the Observatory of Brussels, and his conclusions therefrom, constitute a contribution of high importance to the knowledge of the zodiacal light. Heis has published the results of his observations of the zodiacal light from 1847 to 1875; and Serpieri is discussing carefully the observations of Chaplain Jones, U. S. N. Mr. Henry C. Lewis, of Germantown, has made an extended series of zodiacal light observations. Wright, of New Haven, has investigated the spectrum of the zodiacal light, and also the chemical constitution of meteorites. This last research tends to establish more fully the relation between comets and meteor-swarms.

The variable stars continue to be observed by Schönfeld, Schmidt, and others; and Schmidt has published during the year many important memoirs on this subject. Schönfeld's second catalogue (Mannheim, 1876), with its copious notes, is of capital importance in this subject. Schmidt has detected a *new* (temporary) star in *Cygnus*, which, for a few days, was of the third magnitude.

CATALOGUES OF STARS.

Among others we note the Coast Survey List of Latitude Stars, 2164 in number. Moesta, of Chili, publishes a second volume of Santiago observations, with an important comparison of his work with that of the earlier observers. Stone's catalogue of southern stars has been printed during the year. The Harvard College catalogue of 373 fundamental stars is noticed elsewhere. Gould, of Cordoba, has a catalogue of 12,000 southern stars. The third Radcliffe

catalogue of 4000 stars is preparing. The Observatory of Brussels is preparing a catalogue of 12,000 stars. Safford has prepared a new catalogue of Standard Declinations for the Engineer Department.

Burnham's catalogue of (about) 10,000 double stars has long been ready for the press; but is temporarily delayed, and will be printed in 1877.

Boss, of Albany, is preparing for the U. S. Northern Boundary Commission a catalogue of 490 stars, which will give standard positions. All trustworthy observations of each star (including Bradley's) have been used and rigorously discussed.

Stone, of Cincinnati, publishes a catalogue of 50 new double stars.

Schönfeld's second catalogue of 143 variable stars has appeared during the year.

MISCELLANEOUS.

We note the establishment during the year of Königsberger's *Repertorium der Reinen und Angewandten Mathematik*, under the editorship of Dr. Leo Königsberger and Dr. Gustav Zeuner, of Dresden. This periodical will have the novel feature of abstracts of works on Astronomy, Geodesy, Mathematical Physics, etc., by the authors of the works themselves. The *Analyst* of Professor Hendricks, at present our only mathematical journal, continues to maintain its position.

It is understood that a mathematical journal is proposed to be published by the Johns-Hopkins University, under the experienced editorship of Professor J. J. Sylvester.

The publication of a selection of the works of Bessel, by Dr. Engelmann, of Leipzig, deserves a special mention. A similar compilation for the works of the elder Herschel is much to be desired.

The opening of the Loan Collection of Scientific Apparatus at London has been an event of great importance during the year. The special features are described in detail in another place. The astronomical instruments of the Centennial Exposition were mostly of the ordinary constructions, and, although exhibiting well the present practice of field astronomy and geodesy, presented few novel features. A good exhibition of optical glass was made by Feil, of Paris, and Chauce, of Birmingham. The calculating-engine of Mr. George Grant, of Boston, and some special optical apparatus and material, were particularly noteworthy.

A series of astronomical drawings exhibited by Trouvelot, of Cambridge, was especially interesting, on account of the great facilities at the artist's command for viewing the objects represented, most of them having been examined with the Harvard College refractor (15 inches).

The progress of the zone observations undertaken by the German Astronomical Society, one of the most important works of the decade, will be found described in another place.

METEOROLOGY AND TERRESTRIAL PHYSICS.

BY CLEVELAND ABBE.

METEOROLOGY.

The most interesting feature in the progress of meteorology during the year has been the increasing attention paid to the deductive study of atmospheric movements, as evidenced by the works of Blanford, Ley, Hann, Mohn, and Goldberg, all of whom have contributed to a clearer knowledge of the *rationale* of the winds and currents of the air. In climatology we have to record the publication by the Smithsonian Institution of the temperature tables and the winds of the globe. New data have also been published from regions hitherto but little known—such as the volume of meteorological observations in the Amoor Valley, edited by Von Schrenck, for the St. Petersburg Academy of Sciences; the monthly barometric and other means for stations in the Argentine Confederacy, published by Dr. Gould; the two volumes of details of observations published by the Canadian government.

Of daily weather maps, those published by the Danish and the United States Weather Bureaus have the widest circulation; the former has been extended so as to form a continuation of the United States maps. The daily bulletin of simultaneous observations, taken throughout the world at 7.35 A.M., Washington time, has been maintained by the Army Signal Service; and the specimen maps published of a weather chart, embracing the entire northern hemisphere, show that when published for every day, these will mark a new epoch in meteorology.

We have in the following summary briefly noticed some of the meteorological events of the year and the publications that have been received, arranging the notes, as far as possible, in the following order, viz.:

A. Meteorological Societies, Institutions, and Individuals.
B. " Instruments and Methods.
C. " Investigations and Results.

A. INSTITUTIONS AND PERSONS.

At the Geographical Congress at Paris a letter of merit, being the highest award there recognized, was presented to the United States Army Signal Service for the perfection of its organization and the usefulness of its works.

In the annual review of meteorological work at present in progress in England, the *Quarterly Journal* of the Meteorological Society states that the marine meteorology of the equatorial regions of the Atlantic Ocean, as compiled at the Meteorological Office in London, may be expected to be published during the year, and that upon the completion of this work the office will proceed to the study of the meteorology of the neighborhood of the Cape of Good Hope. The office continues also the collection of data relative to the weather of the North Atlantic Ocean during August, 1873, in which month, it will be remembered, the great hurricane occurred in Nova Scotia. For this purpose some 280 logs of vessels have already been received.

The office has also undertaken the investigation of atmospherical conditions at high altitudes, and has therefore established a station at Settle, in Yorkshire, England.

The Scottish Meteorological Society have set on foot an inquiry into the causes of the earliness or lateness of salmon, by means of observations made with thermometers continually immersed in the rivers and in the sea adjoining their mouths, and by gauging the water of the rivers.

The Scotch Herring Fishery Board have also continued their investigations into the connection between meteorology and the success of the fisheries. Similar observations have been continued in America by the co-operation of the Fish Commissioners and the Army Signal Office.

The continuous photographic records of the barometer obtained at the Greenwich Observatory for nineteen years (1854 to 1873) are being studied, by Professor Airy, with reference to the possible existence of any measurable lunar atmospheric tide.

At Edinburgh Professor Smyth repeats the expression of his confidence in the possibility of recognizing particular sets of lines or bands in the spectrum of daylight, which bands acquire a marked prominence whenever the atmosphere is charged with watery vapor at high temperature, or whenever rain is imminent from the southeast.

Dr. Köppen, of St. Petersburg, has, it is stated, accepted the directorship of the German Seewarte, at Hamburg, whose object it is to study meteorology on a large scale, embracing the movements of the whole atmosphere of the globe, for which work his published memoirs prove him to have a peculiar adaptation.

The annual volumes for 1874 and 1875, published by Professor Kingston, of Toronto, show the great attention paid to the subject of meteorology in the Dominion, and the energy with which the system is being extended. The tri-daily simultaneous observations of temperature, pressure, and wind are published in full for fourteen stations, and monthly means are given for numerous others.

At Vienna the annual volume of observations in Austria for 1874

has appeared with customary regularity. The tri-daily observations are published in full for ten stations of the first class. Monthly and annual means are given for over a hundred stations of the second and third classes, followed by a general review of the temperature and rainfall and by the average temperature of each pentade of the year, according to Dove's system, for about a hundred and twenty stations. The magnetic observations made at Vienna are also given in full. The phænologic observations are a very prominent feature in the Austrian and Belgian climatological reports, and are given in full for thirty-three stations and for over one hundred plants in the present volume.

The results of observations on the fisheries made on the German coast, and their connection with the physical peculiarities of the North Sea and the Baltic, have been published at Kiel in monthly parts, which give, first, physical observations made at ten stations on the Baltic and seven on the North Sea coasts; second, meteorological observations made at Kiel, Lubeck, Westerland, and Helgoland; and, third, fishery statistics for seven stations on the Baltic and one on the North Sea. The physical observations include determinations of the temperature of the water at the surface and at considerable depths below; the height of the water at morning, noon, and evening; its specific gravity at and below the surface, and the direction and velocity of the current. The fishery statistics give the total catch of the five more important kinds of fishes, namely, herring, sprat, haddock, flounder, and salmon; and also the details of the methods employed in fishing for each.

The *Annalen* for 1874 of the Central Physical Observatory at St. Petersburg was published in February, 1876, a degree of promptness equaled only by the punctuality of the publications at Greenwich; but far more surprising when we consider that the 600 pages of the present volume relate, not to work done at single stations, but at ninety stations scattered over the Russian domains. Such a result is certainly a high tribute to the excellence of the system and energy which Professor Wild has infused into the great Russian establishment. A very complete statement is given of the peculiarities of each station, and the observations, which are published in full, as in former years, are accompanied by a monthly and annual *réeumé* arranged very nearly according to the form of publication recommended by the Vienna Congress, an accordance which will be more perfectly attained in the succeeding volumes. The hope has been earnestly expressed on all sides that the French, British, and American meteorological offices will ere long take steps to insure a similar conformity in their climatological publications.

One of the most valuable contributions to meteorological literature is the *Repertorium fur Meteorologie*, published by the St. Peters-

burg Academy of Sciences, under the editorship of Professor Wild, and which has now reached its fifth volume. Professor Wild announces that the Central Physical Observatory at St. Petersburg has received from the Grand Duke Constantine au eligible piece of land in the imperial park near the city, at Pavlosk, and the necessary appropriation of money for the erection of an auxiliary meteorological observatory.

The Imperial Meteorological Observatory at Tokio, Japan, has, under the direction of the government surveyor, Mr. McVean, continued its observations, and has published five day means and reports in the Yokohama papers.

In addition to the labors of Mr. McVean at Yokohama, it is understood that the Japanese government has taken some steps toward the establishment of more extensive meteorologic studies. On the one hand the Kai-ta-ku-shi, or the department for the colonization and development of Jesso, determined, in 1874, to establish eight stations on that island, and intrusted the organization of the whole system to Professor G. J. Rockwell; and, on the other hand, the general government is looking to the organization of a system of observation, and, as far as possible, of telegraphic reports, throughout Niphon and the lesser islands, under the general supervision of the department of education.

Professor Foster, of Berne, Switzerland, in presenting the report of observations for 1873 and 1874, states that a special meteorological observatory is now being erected in Berne, which will attend especially to the relations of the atmosphere, to agriculture, forestry, and hygiene.

The Italian Meteorological Commission has made an elaborate investigation and report, in which certain regulations are recommended which will secure almost perfect uniformity among the Italian observers.

The phenomena of the upper strata of the atmosphere are annually receiving increased attention, especially in France and America; in the former country not only frequent balloon voyages, but three permanent mountain stations contribute to our knowledge of the subject; in the latter country, Mr. A. S. King, the aeronaut of Boston, has continued to make numerous voyages, of which he keeps careful record, and much is anticipated from observations to be made by him, at Philadelphia, in a captive balloon. The publication of De Fonvielle's *Aventures Aeriennes* is an important contribution to this subject.

A report of the British Royal Science Committee will, it is said, probably result in soon terminating the anomalous and embarrassing position that the London Meteorological Office has long occupied in reference to the government.

Professor Hinrichs has continued to collate and publish the rain-

fall reports from numerous stations in Iowa. Predictions are also made by him as to the probable weather for the coming month.

An office for the study of maritime meteorology has been opened at the "Dépôt des Cartes et Plans" in Paris, under the superintendence of M. C. Ploix.

Gautier, of Geneva, has taken especial pains to secure meteorological observations in Labrador from the Moravian missionaries, and has published those made between 1867 and 1874. Besides these, there exist also some records due to Lamont, of observations about 1841. The original record of observations made by the first missionaries in Labrador, from 1776 to 1784, seems to have been accidentally lost to science, until, in 1873, it fell into the hands of the author, who is engaged in preparing them for publication.

The Permanent Committee of the Vienna Meteorological Congress held its third annual session at Utrecht, in June, 1876; it was reported that almost perfect uniformity had been attained in the publication of climatological statistics for purposes of international exchange. With reference to barometric gradients, it was resolved that they should be expressed either on the English scale of tenths of an inch per English mile, or on the metric scale of millimeters per degree (69½ statute miles). The next meeting of the Permanent Committee will be held at Rome, September, 1877, on the occasion of the reassembling of the General Congress.

The Observatory at Melbourne has published three fine volumes of meteorological observations made in 1872, 1873, and 1874 throughout the colony of Victoria. Mr. Ellery states that he has already joined in the American system of simultaneous observations, which is now of world-wide extent.

The Director of the Geological Survey of Brazil, Professor C. F. Hartt, writes that he hopes to be able to secure a proper attention to meteorology in that important empire.

The Observatory at Batavia, under Dr. Bergsma, has published in a large quarto volume the hourly observations made from 1866 to 1870.

B. Instruments and Methods.

The most important event in matters relating to instrumental meteorology has been the exhibition of the Scientific Loan Collection at the South Kensington Museum, where an almost exhaustive array of every conceivable form of apparatus for meteorological research was presented for the inspection of visitors; in connection with these an admirable catalogue and a hand-book were published by the Royal Science Commission. In the latter volume, dissertations were contained by eminent specialists, that on meteorology by R. H. Scott. In the same connection a series of scientific conferences was held; that on meteorology occupied three days, ending June 2d.

The Centennial Exposition at Philadelphia has also been of considerable importance to American meteorologists. There was exhibited there, in active operation, the very beautiful and efficient printing meteorograph, invented by Theorell, of Sweden, as also one by Baumhauer, of Haarlem.

Apparatus by the best European and American makers was also exhibited; especially noticeable was the complete display by the Army Signal Office of its own methods and instruments.

The general rules for observers as recommended by the Vienna Congress of 1873 have been very widely accepted by national systems of meteorological observation, as shown by the annual reports of Wild at St. Petersburg and Scott at London; and especially in the uniformity introduced into the publications of the climatological observations at Vienna, Christiania, Copenhagen, London, St. Petersburg, and Constantinople.

The aneroid barometer has received great attention of late years, and bids fair to rival the ordinary mercurial barometer for most purposes. The best instruments appear to be those made by Naudet & Co., of Paris, and Goldschmid, of Zurich, both of which embody improvements that appear not yet to have been adopted by other makers.

The ordinary aneroids have been made the subject of a rather careful investigation by Grassi, of Pavia, who has considered especially their adaptation to hypsometric work. In the course of his memoir he brings to light the hypsometric formula of St. Robert, which seems to be but little known outside of Italy, but which gives quite as good results as Ruhlmann's.

Professor Schreiber, of Leipsic, has also paid much attention to the reliability of the aneroid barometer, and maintains that with proper care the instruments of Goldschmid, Hipp, and Naudet are probably equal in reliability to mercurial barometers, provided only that a proper degree of care be taken in their use. Both kinds of instruments are, he maintains, essentially relative, rather than absolute, in their indications; both are liable to serious accidental errors and changes, and both require to be transported with the same tenderness. He especially criticises the too common habit of reading the aneroid as it hangs vertically, and maintains that it should be kept with its face horizontal, quite as carefully as a marine chronometer which is hung in its gimbals.

Staff-Engineer George, of the British Navy, proposes to refill a mercurial barometer, when used in traveling, at every station occupied by the observer, and to empty it before packing it away for transportation. He removes any bubbles of air that might be likely to remain in the tube, not by boiling the mercury, which is both tedious and dangerous, but by mechanical means, viz., the introduction simply of a wire, to the end of which a feather is attached, the

repeated twirling of which within the tube agitates the mercury and dislocates any bubbles of air.

Professor Kedzie, of Lansing, Michigan, has made a series of ozone observations, which are published by the State Agricultural College. He recommends that such observations be continued, and gives the necessary directions. The subject is one which observers will not consider to have been satisfactorily settled even by the adverse decision of the Vienna Congress and eminent specialists.

Mr. Scott, of London, communicates to the Meteorological Society some observations, showing that, on the average, the French "Thermomètre Fronde," or whirling thermometer, is not a very decided improvement upon the ordinary fixed thermometer, when the latter is properly sheltered from radiations.

Marié Davy has published, in the *Bulletin* of the Observatory of Montsouris, full details of all the special apparatus employed there to study the physics of the atmosphere, by which is especially meant the study of the part played by aqueous vapor, both visible and invisible.

Bosanquet publishes two papers on the "Polarization of the Light of the Sky." This obscure subject received, in 1865, a new interest from Tyndall's observations on the delicate blue colors and polarized light of finely divided vapor. Bosanquet has now for the first time shown the full bearing of these observations upon the subject of atmospheric polarization. He shows that the diminution of the maximum polarization from zenith to horizon may be regarded as due to a small increase in the mean size of the particles. Except in so far as modified by this circumstance, the phenomena observed in the sky should be arranged symmetrically about an axis drawn toward the sun, and the neutral points of Brewster and Babinet become merely special points in a neutral circle about the sun, while the neutral point of Arago belongs to a similar circle about the antesolar point. Within these small circles the polarization is negative, except at their centres, which ought theoretically to be the only neutral points in the sky. It is hoped that these difficult but valuable observations will receive the attention they deserve on account of their bearing upon the moisture of the air. Bosanquet has in a second memoir, published in the *Philosophical Magazine*, given a method of constructing a polarimeter especially adapted to these delicate observations.

Great interest has been excited by the ingenious radiometer invented by Mr. Crookes. Some meteorologists in Europe have, we believe, undertaken regular observations with the instrument, in hopes of obtaining thereby a measure of the total radiation of the sun. In this, however, we presume they are doomed to disappointment, since it seems to have been abundantly demonstrated that the rotation of the disks is due to only a small portion of the solar radia-

tion, being merely a consequence of their heating effect. It may, however, be that the instrument, in a modified form, can be used as an additional means of investigating the important question of the absorption of the sun's heat by the atmosphere. Among those who have published investigations on the radiometer may be mentioned Poggendorff, Carrington, Reynolds, Stoney, Dewar, and Tait, all of whom maintain that the kinematic theory of heat fully explains its motions.

The subject of solar radiation has been officially taken up by the Meteorological Society of England, which undertakes to carry on the work begun by the Rev. F. W. Stowe; the society will, however, adopt the comparison of the black with the bright bulb thermometer, both in vacuo, instead of comparing the black in vacuo with the maximum temperature of the air as recorded in the shade.

In connection with this discussion a new series of observations has been begun, and eleven stations have undertaken observations on the new plan, from which interesting results must be expected. Among these stations is the observatory at Kew, at which the registering sun-dial invented by Mr. Campbell is now in action, it having been already in operation for several years at Whitehall. This instrument consists of a glass sphere set in a wooden bowl; and the effect of the sun is measured by the amount of wood charred by the sun's action in the course of six months.

Mr. Roscoe appeals to the meteorological observatories of the world to carry on some systematic observations upon the varying chemical intensity of the direct and diffused solar light. The improved apparatus devised by him is, he states, as simple as could be wished; he has made most minute investigations into its errors, and will undertake the determination of the relative corrections with respect to the apparatus belonging to other observers, if so desired.

An elaborate work on the source and quantity of work done by hot-air balloons is published by Papper, who shows that the application of air balloons heated by the solar rays, as motors, in place of our present machines which use coal as the source of heat and work, is not likely to unite economy with moderate size.

The important hygrometric studies of Dufour have been continued by him, and form the basis of a second memoir on hygrometric diffusion through partitions of porous earthenware. The results obtained in his earlier researches are fully corroborated, and minuter investigations have led to still further elaboration of the same complex subject. It would appear, however, that the hygrometer composed by him originally may still be relied upon, although each special instrument must require careful investigation and comparison with the standard. This hygrometer being adapted to give continuous records like that employed by Bache at Philadelphia, and being far less troublesome in its operation, may possibly come into general use.

The correction of hygrometric observations for the altitude of stations above sea-level, which is very large at altitudes exceeding a few thousand feet, but which is frequently neglected by meteorological observers, can be made very easily by means of the table published by Hotier in the last annual report of the Commission du Pic du Midi.

The ninth annual report of the Warden of the Standards in London gives, besides current work, a special account of the recent reverification of official standards of weight, capacity, and length. Among the appendices a description is given of the new balance designed by Mendeleff, one peculiarity of which is that it has very short arms, although adapted to weigh large masses.

Some very interesting aerodynamic experiments have been suggested by Professor Tait in connection with the dead heat arrangement proposed by Sir William Thompson for delicate chemical balances. This arrangement is very sensitive to the least current of air blowing upon it, and may be made the means of investigating the diminution of pressure that takes place in a direction at right angles to any current of air.

A series of observations has been instituted by J. W. Osborne, of Washington, who has proposed that observers keep a record of the temperature and its changes so far as they are sensible to the human body, and can be estimated without regard to thermometers or other instruments. He has, therefore, provided a scale of terms from one, which is unendurable cold, to twenty, which is unendurable heat. A large number of observers having volunteered to assist him in Washington and its vicinity, he has been able to show that very satisfactory agreements exist between the estimates of different observers, and that the diurnal and annual changes in sensible temperature are well marked. From such observations as these he hopes to obtain an idea of the relative climates of different portions of the world, so far as they affect the human system, more satisfactory than can be deduced from the study of ordinary meteorological and instrumental records. Observers in Washington and in Ohio have co-operated in this system.

Professor Wild, of St. Petersburg, has introduced a new form of siphon barometer, which consists essentially of two vertical tubes firmly inserted into the closed cisterns. It is said by him to be more accurate than the ordinary cistern barometers, although also heavier and more costly.

The same physicist has also published a careful comparison of wet and dry bulb thermometers, observed both with and without a brisk artificial ventilation. He finds the effect of the artificial currents quite insignificant as regards the dry bulb; but they, of course, lower the wet bulb, and sufficiently in the summer time to diminish the apparent humidity. On the average, however, he concludes that the

ordinary thermometer screen, without ventilation, gives the temperature of the air accurate to one twentieth of a degree Centigrade.

Theorell invented, for the use of the Swedish Arctic Expedition, an anemometer which maintained a continuous register for the direction and velocity of the wind, notwithstanding the intense cold to which it was exposed. A full description of it has been recently published in Wijkander's Memoir, in the 12th volume of the Swedish Academy.

The study of solar radiation by the apparatus invented by Violé has been prosecuted by him by means of observations made on Mont Blanc, and at lower stations. He concludes the temperature of the solar surface to be about 1500° Centigrade.

Dr. Robinson, of Armagh, has made an important contribution to anemometry by the publication of a new analytical theory of his well-known anemometer.

Du Claux shows that mixtures in definite proportions of crystallizable salts in water deposit their crystals at very definite temperatures, and may therefore be used, in some cases, as thermometers.

Jannsen has, by means of temporary apparatus at Montmartre, been taking daily photographs of the sun. He records that during the cold spell in France, the first part of May, there were no solar spots visible—a fact quite in accordance with other investigations, according to which, in high latitudes, the coldest seasons occur when few spots prevail on the sun.

Professor Houston, of the Philadelphia High School, states that he is at work on a proposed improvement of the barometer, in which he hopes, by means of a scale floating on the surface of the mercury, to read with greater ease and precision the atmospheric pressure.

Dr. Hellmann, in his discussion of wind observations, suggests that we need instruments which shall measure both the vertical and the horizontal components of the motion of the wind.

C. Investigations and Results.

Professor Loomis has continued his contributions to American meteorology, which have been uniformly published in the *American Journal of Science* after having been first presented to the National Academy of Sciences.

In his fifth paper he gives a collection of data relating to hurricanes, and deduces for American storms a connection between rainfall and the progress of storms.

Maquenne has made an important determination of the power of leaves to absorb and radiate heat. His experiments, of course, were conducted at temperatures not exceeding 120°; and the radiative powers averaged from 91° to 97°; while the absorptive powers varied from 94° to 97°, lampblack being adopted as the standard of comparison.

Dr. Hellmann has contributed a discussion of the observations made by the Army Signal Office at Mount Washington. He finds the diminution of temperature with altitude agrees nearly with that prevailing in Central Europe. The diminution is most rapid with northwest winds, and least rapid with southeast winds.

In a review, by Caspari, of a rare work, by Isaac Vossius, "De motu Marium et Ventorum," published at the Hague in 1668, it is claimed that Vossius was the first to definitely promulgate the rule that it is the rising and falling of the barometer, and not simply its absolute height, that should guide us in predicting the weather.

Considerable light has been thrown upon the formation and activity of ammonia in the atmosphere by the works of Schloessing and others, according to whom the direct assimilation of simple gaseous nitrogen by plants, and the emission of ammonia, is not admissible. The formation of ammonia is by them attributed to the chemical action of ocean water upon the nitric acid carried into it by rain and rain-water.

The effect upon the barometer of any movement in the air is deduced by Montigny from observations in the tower of the cathedral at Anvers. He concludes that the barometric pressure diminishes less rapidly during west winds, and most rapidly during east winds.

Ley finds that of 800 storms passing near Great Britain during nine years, the large majority had a tendency to move in directions parallel to the trend of the steepest gradients; thus when the isobars are closest on the southeast side, the tangents trend toward the northeast, and fifty-five per cent. of these storms move in the same direction. He finds also evidences of a less important disturbing force tending to make the depressions move toward the northeast by east. It would be interesting to compare Ley's rules with the behavior of American storms. We can see no reason why they should obtain for the storms occurring between the Rocky Mountains and the Atlantic coast.

Blanford, of Calcutta, has published a memoir on the winds of Northern India, which is a very fine example of inductive reasoning. His object has been to describe normal wind-currents of Northern India and their annual variations, and to trace out their origin and causes in so far as these can be discovered in the local physical changes in the atmosphere. These causes are, of course, found in the variable moisture and heat, and the peculiar topography of India. Very well drawn charts are given, showing the relation between the movements of the winds and the clouds.

Mr. Blanford's conclusions with regard to the origin of the cyclones of the Bay of Bengal apparently accord best with what we know of similar storms elsewhere. "They form in a region of calms or variable winds; an area of barometric depression and rising temperature is formed several days before the cyclone is generated; cur-

rents of air set in converging toward this area; finally, if among these currents there rushes in a strong southwest or west-southwest current of air saturated with moisture," this furnishes the required abundance of vapor, whose rapid condensation gives out the heat required to form and maintain a cyclone, instead of the small tornadoes that would otherwise be the only result.

In reference to the relation between solar radiation and terrestrial meteorology, Blanford remarks that in India both the annual and diurnal changes in temperature are the reverse of the changes in humidity; it would therefore seem that throughout the world, since there is more water than land surface, the principal effect of an increase in the temperature of the sun would be to increase the quantity of moisture in our atmosphere, and to diminish the temperature of the air at the immediate surface of the earth.

Planté states that he has observed certain effects that go to show that the formation of hail is due to an electric discharge of low tension accompanied by a gyratory movement of the electrified particles of ice.

Gronemann has published additional developments of his theory of the origin and nature of the aurora, which is that it is an electric discharge among particles of cosmic dust, clouds of which are encountered by the earth in its annual course around the sun. He finds the explanation of the geographical distribution of the greatest auroral frequency in a zone lying between the parallels of 50° and 70° of north latitude to consist in the relation between the position of the earth's axis and the orbits pursued by the cosmic dust. According to this theory there may be periodical auroras — one of which may possibly recur on the 4th of February.

Fritz has compared the frequency of auroras, as recorded in his great catalogue, with Wolf's observations of the sun-spots. He finds that the most important auroras agree accurately with the minima of sun-spots, and that the great aurora period of fifty-five and a half years also agrees with five of Wolf's sun-spot periods: he even thinks it probable that a still longer period of two hundred and twenty-two years may be detected in the records of the auroras.

Buys Ballot and Wild have published extensive researches upon the distribution of atmospheric moisture or relative humidity in Europe. The former finds the data sufficiently extensive to justify the formation of monthly means and corresponding deviations from the normal values; he also deduces the influence of altitude above sea-level, and of latitude, longitude, and the neighborhood of the ocean.

Hann has published an essay on the climate of the Punjab. Among the many interesting items we note that the average range of temperature in a day is from 16° to 20° Centigrade at the three stations where observations have been made for several years; the actual temperatures averaged 33° Centigrade in June, and 10° Centi-

grade in January. The comparative dryness of the air is seen from the fact that the average humidity throughout the year is about fifty per cent. The observations at some of the high stations seem to suggest that the minimum temperatures at an altitude of 7000 feet are possibly higher than the corresponding minima in the low lands. Among the stations showing a large rainfall we notice Kangra, where the annual fall amounts to 110 inches, while at Simla and Dehra the corresponding amounts are fifty and sixty inches.

Professor Langley, in an article on the solar atmosphere, gives the results of his measures of the distribution of heat and light over the solar disk; the absorption of heat takes place, he thinks, principally in a thin stratum at the base of the chromosphere. The slightest change in the solar atmosphere has an appreciable effect on the absorption, so that we have here at hand a sufficient cause for those variations in solar heat that geological observations seem to demand. The absorption is also selective, so that the sun tends to have a bluish tinge when the absorbing layer is thin, but to have a reddish tinge at other times, affording us thus some rational hypothesis whereby to explain the phenomena of variable stars.

The influence of atmospheric moisture upon the absorptive power of the atmosphere has been further illustrated by Hoorweg, who has, by a renewed series of observations, conclusively shown the general correctness of Tyndall's results, according to whom a small percentage of vapor in the atmosphere increases enormously the absorption and radiation of obscure heat, and moderates terrestrial climates.

More recently still Lohse has, with great acumen, discussed the observations of Tyndall, Magnus, and Wild, and has added an excellent investigation of his own, showing that the effect of aqueous vapor is by no means as decided as maintained by Tyndall.

The relation of warm, dark heat rays to hydrogen and the atmosphere has been studied by Buff, of Giessen, who has repeated a series of experiments bearing on the absorption of heat by the atmosphere, and concludes that hydrogen is as nearly transparent to heat as a vacuum, while dry air absorbs fifty or sixty per cent. of heat rays. The assumption of Tyndall that the power of damp air to absorb rays of heat coming from a dark source exceeds by fifteen to forty per cent. the absorptive power of dry air is incorrect. It is correct, however, to say that such heat rays as are not absorbed in dry air can become absorbed, or do experience a very sensible diminution when passing through damp air.

Mendeleff endeavors, by means of Poisson's equation, to arrive at formulæ by which we may calculate the temperature of rarefied air with a high degree of approximation. In reference to the expansion of air by heat, he has shown that for pressures between 750 and 770 millimeters the coefficient of dilatation of the air is 0.00036843 for 1 degree of Centigrade.

An excellent contribution to our knowledge of the chromatic dispersion of gases has been made by Lorenz, of Copenhagen; and his investigation of the coefficient of refraction of aqueous vapor will find an important application in the spectroscopic study of the atmosphere.

Hennessey has engaged in an elaborate work on the atmospheric lines of the solar spectrum. His observations were made among the outlying hills of the Himalaya Mountains at an elevation of 1700 feet. In this region, near sunset, atmospheric lines are remarkably well developed, and the effect of aqueous vapor is truly startling. There can be no doubt that in the hands of skillful observers the spectroscope must become an invaluable meteorological instrument, and will perhaps eventually give quantitative as well as qualitative indications.

Two very elaborate memoirs are to be found in the official publications of the Italian Meteorological Office. One is due to Denza, on the distribution of rain and barometric pressure in Italy; the other, by Ragona, is on the distribution of temperature.

Professor Reynolds has made a further communication to the Royal Society on the refraction of sound by the atmosphere, fully confirming the positions previously advanced by himself and by Professor Henry. Interesting relations seem to exist between these phenomena and the state of the atmosphere before or during storms, etc.

Jordan, of Carlsruhe, contributes to the theory of atmospheric refractions an article in the *Astronomische Nachrichten*, in which he shows that, without making any assumption as to the decrease of temperature with altitude, we may, by a general assumption as to the curvature of the ray of light, obtain simpler tables and better results than by any of the tables now in use. Inversely, then, the average temperature of the air can be determined from refraction observations, as others have done from barometric observations, and thus valuable new meteorological results arrived at.

An interesting paper, both in a theoretical and practical point of view, is that by Dr. Von Lang, of Vienna, on experiments on the friction between water and air. These experiments were made by measuring the amount of air drawn along after a falling column of water. The friction of air slipping over the surface of water and causing it to slowly follow is one of the important elements in terrestrial physics, and is directly involved in Von Lang's experiments, which have also a direct bearing on the origin of the gust of wind that precedes falling rain and hail.

The severe storm of March 12, 1876, has been the subject of a memoir by Quetelet, according to whom it was the severest that has been observed at Brussels since the period of exact observations at that place.

Montigny contributes an investigation into the law of diminution

of pressure in the atmospheric strata during storms, and shows that according to the direction of the wind and the condition of the barometer as to rising or falling very marked deviations may be noted at moderate altitudes from the normal distribution of pressure. For instance, during easterly winds in Belgium, the barometer at the upper station is low, during westerly winds it is high.

Von Bezold has published a second memoir on the phenomena of thunder-storms in Europe, in which he shows that there is a pretty well marked double maximum during the summer months in the northern hemisphere, and that these maxima are the better distinguished from each other in proportion as we go farther away from the equator; wherefore he suggests that they may be considered as due to the existence of the two summers of equatorial regions, or, in other words, that they follow the two passages of the sun across the equator in the course of the year.

The diurnal variability of temperature has been investigated by Hann, who has extended his observations to a large number of stations scattered throughout Europe and Asia. He shows that the daily variability reaches its maximum in the interior of North America. A second region of maximum is found in Western Siberia, at a higher latitude than in America.

The shores of the Caspian and Baltic are visited by storms of fierce northerly winds, precisely similar to the "northers" of the Texas and Mexican coasts. A detailed study into the phenomena of the Bora, as it is called, at Novarussisk, has been published by Baron Wrangell. According to him, the violent winds that visit this fine harbor acquire their force from the fact that they consist essentially of cold dense air, which descends the mountain-sides. He calculates theoretically the violence of the wind; and having shown the satisfactory agreement of his formula with actual observation, concludes that his explanation of its origin must be accepted, and thence is led to propose a method by which the harbor may be protected, or, rather, by which the wind itself may be diminished, if not prevented.

The movement of water in rivers has been the subject of a series of very extensive experiments by Captain Allen Cunningham, of India, and his work ranks in importance with that of Humphrey and Abbott, and the recent investigators in Europe.

An excellent memoir has been published by Dr. Armieux on some results of observations made on the Pic du Midi, and especially on the presence of red snow in the Pyrenees, and on the general history and condition of the question as to the exact nature of this phenomenon.

The formation of snow crystals has been observed by Tissandier in a balloon ascension: he notes that a stratum of warm air accompanied the thin stratum of ice crystals; the higher temperature was

undoubtedly due to the evolution of heat during the formation of snow.

Van der Mennsbrugghe shows that every disturbance in the surface of a liquid gives rise to electric currents, and deduces thence the conclusion that the change from invisible vapor to condensed drops of fog or rain must affect the atmospheric electricity, while the original evaporation of water from the ocean is a constant source of electric currents; whence he frames a comparatively simple theory to account both for terrestrial electricity and atmospheric electricity.

Lemstrom has developed, in the Geneva *Archives*, his views on the nature and origin of the aurora. His theory regards this as mainly a terrestrial phenomenon, due to electrical discharges through the upper regions of thin air (similar to the discharges through a Geissler tube), and also between this air and the earth; according to him, the upper stratum of air forms a great conductor, which is nearer the earth in the polar than in the equatorial regions.

The aurora of April 7, 1874, has been elaborately investigated by the author in a memoir published in the Annual Report of the Chief Signal Officer of the Army. In a note on the origin of atmospheric electricity, Professor Tait states that he has been making a series of experiments to ascertain the part played by aqueous vapor in the production of atmospheric electricity. While water is in the form of vapor, it must be electrified by contact with the gases of the atmosphere, as they are by contact with each other. He finds that the precipitation of vapor in a receiver, whether produced by cold or by exhaustion of the air, is always accompanied with a disengagement of electricity. Further experiments with receivers of very great capacity are promised by Professor Tait.

TERRESTRIAL MAGNETISM.

No. 14 of the contributions to Terrestrial Magnetism, by General Sir Edward Sabine, is published in Vol. CLXV. of the London Philosophical Transactions. In this he presents the second half of the magnetic survey of the northern hemisphere, of which the first half constituted No. 13 of his contributions. These two papers, taken together with No. 12, which belongs to the southern hemisphere, embrace fully three fourths of the entire globe. In the present paper, declination, inclination, and magnetic force in British units, and corrected as far as possible to the epoch of 1842.5, are given for all available stations, arranged in four zones 10° broad, from the equator northward. A table is also given, comparing the observations published by Sabine with the formulæ and observations of Gauss and Weber.

The magnetic observations made at twelve of the stations occupied by the Transit of Venus parties were conducted in accordance

with instructions emanating from the Observatory at Stonyhurst, in England. They were continued for about five months at intervals of every two hours, and will afford valuable data relating to terrestrial magnetism.

The Bureau of Longitudes at Paris has published a map of magnetic variations for France, for 1876, prepared by Marié Davy, which will hereafter be issued annually in connection with the *Annuaire* of the bureau.

Lieutenant Weyprecht presents a synopsis of the results of the magnetic observations made by the Austrian Polar Expedition under his command in 1872–1873, in which he states that declination, inclination, and total intensity are greater in the regions traversed by himself than as given by General Sabine for 1840–1845, and than those computed by Erman and Petersen for 1829, according to Gauss' formula. His observations of daily variation are the only ones as yet published from arctic regions, except those made at Lake Athabaska and Fort Simpson. From them it seems to result that the total intensity suffered little or no variation in consequence of the magnetic perturbations, which latter affected only the declination and inclination.

VULCANOLOGY.

Of recent publications in reference to earthquakes, we should mention the two important volumes by Schmidt, at Athens, one of which, "Studies on Earthquakes," affords the best collection extant of statistics of this phenomenon and its relation to the moon, the barometric pressure, etc. The second volume, "Studies upon Volcanoes," is especially devoted to Santorin, Vesuvius, Baie, Stromboli, and Etna. In his observations upon these volcanoes, Schmidt has combined the accuracy of an astronomer's studies with the caution of the true investigator.

Serpieri has subjected to a detailed study the observations of earthquakes that have been made in Italy by means of delicate pendulum seismometers. According to Alexis Perry, Serpieri's memoir is one of the most important that has lately appeared on this subject.

Pictet has communicated to the Society of Physical Sciences at Geneva the results of his experiments made in Egypt on the propagation of the heat rays of the sun through different substances, especially sand. He had proposed to himself to verify the idea suggested by Sorat, that the sand acted somewhat like a sheet of glass; that is to say, that it was diathermanous for luminous heat, and athermanous for obscure heat. Pictet has found that in the diurnal changes of temperature a much greater accordance takes place between the sand and the glass than other substances, like wood or coal, even when these two latter have been painted the color of sand.

Mohr shows that the observations of temperature in the artesian

well at Sperenberg conclusively demonstrate that as we descend into the earth the rate of increase of the temperature steadily diminishes, and that therefore, at a given depth, the temperature must become stationary. It follows that the origin of the internal heat of the earth is to be looked for, not in the presence of an internal molten nucleus, but in the chemical or other action going on in the strata themselves. This result is, however, ably controverted by Dunker and Moesta.

In the *Annual* of the Imperial Geological Institution at Vienna we find an essay on springs and their formation, by Dr. E. Tietze.

The study of the internal heat of the earth is much facilitated by lists of thermal springs, such as that compiled by Dr. Gilbert, of Professor Hayden's Survey, and published officially by him. The connection between the thermal springs and the disturbed or undisturbed condition of geological strata is clearly shown by the chart which accompanies Mr. Gilbert's paper.

The submarine explosion at Hell-gate, under the direction of General Abbott, was taken occasion of for measuring the velocity with which the shock was communicated through the earth. Four delicate seismometers were established at stations distant respectively 5, 9, 8, and 13 miles. The velocities of transmission for the corresponding stations were respectively 39, 45, 83, and 58 hundred feet per second. The shock received at each station was of the nature of a continued vibration, and not a short, sharp one. The observers at the stations lay upon the ground and listened to the rumbling of the earth, which occurred simultaneously with the sound. The discordant determinations of the velocity probably should be attributed to the various natures of the strata of rock and earth through which the sound was transmitted.

PHYSICS.

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The progress in physical science has been fully up to that of previous years. In *General Physics*, Crova has suggested a most excellent experiment for showing the relation of heat, electricity, and mechanical work to each other. The apparatus used is a Clamond thermo-battery, a Gramme magneto-electric machine, and a coil of platinum wire inclosed in a glass globe. First, if the wire coil be attached to the battery alone, the heat from the gas flame, transformed into electricity by the battery, reappears as heat in the external circuit. Second, if the Gramme machine be put in the circuit in place of the coil, the electricity developed by the heat is transformed into mechanical work, and the machine acts as a motor. Third, if both coil and machine are put in circuit, heat is produced in the coil, and work in the machine. But if now the machine be stopped, the incandescence of the wire is increased; as it gradually acquires velocity again, the glow of the wire is reduced. The expenditure of heat necessary to produce a given quantity of work is thus made evident to the eye. Finally, if the machine be turned by hand in the direction of its previous rotation, the incandescence of the wire diminishes, until finally a velocity is reached at which the wire no longer glows at all. But if the rotation be in the opposite direction, the incandescence increases until the wire fuses. The additional energy introduced appears as heat.

Ettingshausen has made an ingenious use of the stroboscopic method of Mach for the purpose of studying the uniformity of motion of rotating bodies. The rotations compared were obtained with an electro-magnetic motor with Helmholtz's regulator and an accurately constructed clock-work. The former of these gave the most uniform motion.

Another noteworthy event has been the presentation to the Royal Society of a paper by C. W. Siemens, describing an instrument to which he gives the name of bathometer, and by which the depth of water at any point in the ocean may be ascertained by simple inspection, without the use of a sounding-line. It consists of a vertical column of mercury inclosed in a steel tube having cup-like extensions at its ends. The lower end is closed by a corrugated steel diaphragm, the weight of mercury resting upon it—which is of course affected by the force of gravitation—being balanced in the

centre of the diaphragm by the elastic force of four carefully tempered steel springs—which is independent of any variation of gravity. Being open to the atmosphere both above and below, the instrument is unaffected by variations in the pressure of the air. The peculiar form of the column was given to it in order to render the instrument parathermal, or independent of temperature. The reading is effected either by electric contact or by means of a spiral graduated tube fixed on the top of the instrument, and communicating with the space above the mercury, which contains a liquid of less density partially filling the tube. The graduations are empirical, since this is much easier than calculation. Experiments in the *Faraday* with Sir William Thomson's sounding-line gave 82 fathoms at 12, 204 fathoms at 1.08 P.M., and 69 fathoms at 2.20; the bathometer showed 82, 218, and 78.

In *Mechanics*, Kimball has published the results of some experiments made by him to ascertain whether the coefficient of sliding friction is constant at all velocities, as it is ordinarily stated to be, or whether it varies inversely as the velocity, as certain practical results seem to render probable. The figures given show: (1) that with a given inclination of the plane, the coefficient of friction decreases as the velocity increases, rapidly at first, but more slowly afterward; (2) with the same velocity, the coefficient of friction is greater the greater the inclination of the plane, within the limits of the experiments; (3) that the coefficient of friction in each experiment tends toward a constant quantity; and (4) this constant seems to be the same in each experiment.

The same physicist has studied the changes produced in the physical properties of steel by tempering. He finds (1) that the modulus of elasticity decreases as the hardness of the steel increases; (2) that the increase of deflection in a given time is greater the harder the steel; (3) that the immediate set increases with the hardness of the steel; and (4) that a bar recovers from a temporary set with greater rapidity the harder it is.

The process of M. De la Bastie for hardening glass has met with a formidable rival. F. Siemens, the well-known Dresden manufacturer, has patented a method of hardening, tempering, and pressing glass all at the same time. Instead of plunging the softened glass in a bath of cold oil, the molten glass is run into suitable moulds, and while still highly heated is squeezed, the moulds—which are generally of metal—having the effect of giving the necessary cooling. For blown glass, shells or casings of platinum are made, and these are transferred to the mould together with the glass.

Lawrence Smith has devised a simple form of compensating pendulum, founded on the considerable expansibility of hard rubber or vulcanite by heat. The seconds pendulum he uses consists of a

steel rod 6 mm. in diameter, over the lower end of which is passed a tube of vulcanite 25 mm. in diameter and 165 mm. long, secured by an adjusting screw at the lower end of the pendulum rod. A brass bob 63 mm. in diameter and 156 mm. long slides over this vulcanite tube, and rests upon its top. The upward expansion of the vulcanite should be equal to that of the steel rod and the bob downward. The coefficient of expansion for 1° Centigrade of the vulcanite was 0.000079365.

Cailletet, who has been working upon the problem of chemical action under high pressures, has contrived a simple form of pressure gauge, founded on the compressibility of glass. By experiment he proved that a cylindrical glass reservoir suffers, when compressed, a diminution of volume exactly proportional to the pressure exerted. The new manometer consists, therefore, of a large glass thermometer, with a cylindrical bulb containing either a colored liquid or mercury, and inclosed in a cavity in a steel reservoir, communicating by a brass tube with the apparatus in which the pressure is to be measured. To maintain the temperature constant, the whole apparatus is placed in melting ice during use. The indications are reliable.

Parish has described a simple form of balance for taking specific gravities of solids, constructed somewhat like a common form of letter scale, with unequal arms, the substance being placed in a pan (which can be immersed in water) at the end of the shorter arm, while the longer is graduated directly to give the specific gravity.

Schott has examined the character of the crystallizations which are produced in common glass under various conditions, with a view to elucidate the chemical character of glass itself.

Nipher has published a paper on the variation in the strength of a muscle, in which he calls attention to the fact that after the relation of the strength of a muscle to the dynamical work of exhaustion has been determined, its strength at any time is easily found by measuring the dynamical work of exhaustion. He also finds that the coefficient of power of a muscle per square centimeter of its section is very variable; so that the work a muscle can do depends not alone upon its size, but also upon its quality.

Victor Meyer has devised a simple and very effective method of determining the solubility of salts in solvents, which is rapid and accurate, whatever be the temperature at which the solubility is taken.

Meunier has observed a quartzose sandstone from the vicinity of Orsay, Department of Seine-et-Oise, France, perforated through and through by the roots of trees. The grains of quartz are held together by a calcareous cement, which is the material upon which the carbonic gas exhaled by the roots has exerted its solvent action. These roots were those of the elm, and were of all sizes, from a centimeter and more to less than a millimeter in diameter. The author

thinks that possibly in this way roots may insinuate themselves into rocks far anterior in age, and thus be regarded as much older than they really are.

Lescœur has studied the influence of chemical character upon the gyratory motions which are observed whenever certain substances, such as camphor, for example, are placed on the surface of pure water. He has obtained the result with the acids belonging to the fatty series and with many of their acid salts, though only in a slight degree with normal salts. A fragment of glacial acetic acid, for example, moves very actively on water and dilute acetic acid, but not on the concentrated acid or on mercury. So also of propionic, butyric, and valeric acids.

May has published a memoir on hydrodiffusion, or the diffusion of a heavier liquid into water, in which he gives experimental and mathematical evidence to sustain the hypothesis of Fick—or a modification of it—that the passage of a dissolved substance from one solvent to a second proceeds according to the theorem which Fourier established for the passage of heat along a conductor.

Guthrie has investigated the conditions of production of stationary liquid waves in both circular and rectangular troughs, intending therefrom to deduce the velocity of wave progression from the frequency of the recurrence of a given phase in the same place. With circular troughs he noticed that with binodal motion—*i. e.*, motion produced by oscillations at the centre—the number of vibrations is independent of the amplitude and of the temperature; that the normal rate of pulsation is not reached unless there is a depth of at least six inches; that the chemical nature of the liquid is without effect on the rapidity of oscillation; that the rapidity of progression of such waves varies directly as the square root of the wave length; and that the nodal line of such circular waves is one sixth of the diameter from the circumference. Hence it follows that a wave a meter long would travel 83.07 meters a minute, or a little more than three miles an hour.

Marey has published a valuable memoir on the movements of liquid waves in elastic tubes, in which are given the results of experiments made to elucidate the circulation of the blood, particularly with reference to the character of the pulse as determined with the author's well-known sphygmograph. By means of a very ingenious little apparatus called an explorator, several of which are placed along the length of the tube through which the wave moves, compressed air is made to move a style at the instant the wave passes. This style records the movement, both in time and in form, upon a blackened cylinder, whose surface moves twenty-eight centimeters per second. The author's conclusions from these experiments have a high physiological importance.

The same author has contrived an ingenious dial log for vessels,

by which the speed of a vessel at any given instant may be ascertained by inspection. It consists of two corrugated circular boxes like those used in aneroid barometers, but not exhausted, the one side of each of which communicates with a tube passing into the water. These two tubes are bent at right angles at their lower ends, and face opposite ways. The inside faces of the boxes are connected by means of a rod having rack-work upon it, into which gears a pinion upon the arbor of an index hand. Should the pressure in one box be different from that in the other, the rod would move, and the index too. But whatever the absolute variation of pressure, provided it is the same in both boxes, no effect is produced on the dial. By means of connecting tubes and an aspirator, the whole apparatus is filled with water. Then it is unaffected by the vessel's pitching and tossing, and indicates only the speed with which she passes through the water. By simple means it may be made self-recording.

Romilly has studied the action of a current of air or steam in drawing into its course the surrounding air, using for this purpose various forms of openings and ajutages. The same results were obtained with air and steam, the maximum pressure in the receiver being obtained when the receiving cone has an angle of 5° to 7°, the base directed away from the jet. This latter is placed at a distance from it determined by making the jet the apex, and the opening of the receiving tube the base of a cone of 15°. Then the quantity of air drawn in is directly as the diameter of the two openings (of the jet and receiving cone); the velocity is in the inverse ratio; the pressure is inversely as the section of the receiving tube, the absolute pressure varying according as the receiver is opened or closed. He has also observed that, using a receiver with thin walls, if the jet be removed only a few millimeters from it, and directed not into the opening of this receiver, but just outside of it, and upon the wall itself, a maximum of pressure is produced more than double of that obtained when the jet enters the orifice. Using a jet provided, like the receiver, with lateral walls, there is no longer a pressure, but an aspiration produced, even at considerable distances.

Penaud has presented to the French Academy an important memoir on aviation, in which he describes his new apparatuses for mechanical flight. He divides the systems of aviation already proposed into three classes: helicopters, aeroplanes, and orthopters. In the first, screw-propellers with nearly vertical axes constitute the sustaining power; in the second, the surfaces are nearly plane, inclined slightly to the horizon, and the apparatus is propelled by screws; the third are furnished with organs whose surfaces have nearly vertical and alternating movements. In 1870 one variety of helicopters was constructed which would rise to a height of fifteen meters, and remain in the air for twenty seconds. In 1871 an aeroplane was

presented to the Society of Aerial Navigation, which was most successful. But a year later a mechanical bird was produced which essentially solved the problem.

Moreau has made a series of experiments to determine the precise function of the swimming-bladder of fishes. He shows very ingeniously that fishes which possess such a bladder undergo variations of internal pressure, and hence that they do not, as is generally stated, make use of muscular power to preserve their density unaltered when this pressure changes. The function of the swimming-bladder, then, in Moreau's opinion, is to enable the fish to adapt itself to all depths, not by a mechanical action exerted upon this by means of its muscles, but solely by changing the quantity of air which is contained in this organ.

Wagner has made an investigation of the accuracy of the results obtained with the effusion apparatus of Schilling for determining the density of gases. Three perforated platinum plates were used, having holes of different sizes. With coal gas the density was 0.46 with the largest, 0.47 with the mean, and 0.48 with the smallest opening. Oxygen gave 1.21, 1.08, and 1.21 under these conditions, the true density being 1.10. Hydrogen gave 0.22, 0.20, and 0.23, its actual density being 0.069. Carbonic acid gave 1.51, 1.36, 1.36, instead of 1.52. For gases other than coal gas, therefore, the method is inaccurate. And even for this the variation from the actual density, as determined by the balance, was 0.03, a value of great importance so far as the illuminating power is concerned.

Lecoq de Boisbaudran has proposed a simple form of cock for gas or water. In the middle of a piece of small glass tube a plug is firmly fixed, and a hole is bored into the tube on each side of it. A short piece of larger tube is taken, a cork thrust into it about half its length, bored to receive the first-mentioned tube. This cork has a lateral opening. Both ends of the larger tube are closed with corks, the smaller passing through them. If now the hole in the smaller tube be opposite the lateral opening in the cork within the larger tube, there will be a free flow of water or gas through the whole; but by rotating the tubes half round, the opening in the tube is closed by the cork, and the flow ceases.

ACOUSTICS.

Mercadier has published the results of his experiments on the vibration of steel forks, from which he concludes, first, that the number of vibrations of such forks, other things being equal, is independent of their breadth; second, that the number of vibrations is directly as the thickness; and, third, that this number is inversely as the square of the length. These results are in complete accordance with those calculated from the theory of elasticity in solids. With regard to the amplitude of the vibration as affecting its isochronism,

the author concludes, first, that the vibrations of a fork are not absolutely isochronous, the duration of its period varying with the amplitude and the temperature; second, that consequently any chronographic instrument can give comparable results at different times only if the temperature and the amplitude remain the same; and, third, that if the amplitude does not exceed three or four millimeters, and if the temperature varies but slightly, the number of periods per second may be exact to 0.0001 nearly.

Mayer has given in *Nature* some notes of remarkable experiments in acoustics on the obliteration of one sound by another. He finds that the ticking of a clock, for example, completely obliterates the ticking of a watch at the periods of coincidence, the intensity of the clock ticks which effect this obliteration being three times that of the watch ticks. Moreover, he observes that a sound can not obliterate another lower in pitch than itself—a result of great physiological significance. These facts the author applies to orchestral music, and shows that this obliteration of higher by lower sounds should and does seriously mar the intended effect of the music, and hence that the study of its conditions is necessary in musical composition.

The same physicist has published a preliminary note on two new methods of research in acoustics, in which he asks the privilege of being permitted to develop them. The first is a plan for the determination of the relative intensities of sounds of the same pitch. This is effected by placing a loose membrane any where between the centres of origin of two sounds of the same pitch, and perpendicular to the line joining them, and then by any device determining the position where the membrane ceases to vibrate. The instrument he calls a phonometer. The second is a method for determining the direction of sounds. It consists of a membrane capable of being moved in any azimuth, and which can therefore be placed at right angles to a sonorous wave front. When it reaches this position it can not vibrate, since the impulses are alike on the two sides. To increase the aural parallax, two resonators may be used at the ends of a horizontal rod.

Dvořák has studied certain attractions and repulsions observed in the vicinity of sonorous bodies when they are vibrating. If, for example, a rod of wood be made to vibrate slowly, and a small square of paper suspended by a silk filament be moved slowly around it, the surface of the paper being preserved vertical, it will be noticed that in certain positions there will be attraction, and in certain others repulsion of the paper. The author attributes these movements to currents of air generated by the vibrating mass, and proves his theory by a number of highly interesting experiments.

Müller has experimented to determine the pitch of the notes given by transversely vibrating rods of gypsum when dry and when

moistened with various liquids. His results show (1) that the changes in tone produced by the absorption of liquids are also accompanied by a variation—actually a decrease—in the coefficient of elasticity; this effect is most marked with water, less with alcohol, and still less with oil; and (2) the variations of tone of the various rods when wet, in comparison with a dry rod, follow a definite law, a comparison of the condition of such a rod when it has taken up a liquid showing a change in its modulus which is quite definite in amount, and depends only on the liquid employed.

Bosanquet has communicated to the Musical Association a second paper on temperament, or the proper division of the octave, in which he considers carefully all that has been done in the subject, and suggests a plan of his own for the purpose. To test the question, he has had a harmonium constructed with a compass of only four and a half octaves; but as each octave has fifty-three keys (!), the number of notes is quite sufficient. A previous instrument had eighty-four keys in each octave.

Professor Foster has exhibited to the Physical Society of London the apparatus devised by Mach for sound reflection. It consists of a mathematically exact elliptic tray, highly polished, and provided with a tightly fitting glass cover. The tray is covered with precipitated silica well dried. Upon repeatedly discharging a Leyden-jar between two small knobs placed in one of the foci, the finely divided silica is seen to arrange itself in curves around the other focus.

HEAT.

Wallace has made a series of experiments on the Bunsen burner, with a view to utilize it for general heating purposes. In one form of burner devised by him the tube contains a simple strip of metal so folded as to split up the rising currents, and so producing an intimate mixture of the gas and air. Such a burner will not strike down. In another form, called by him the tangent burner, the gas enters a circular chamber tangentially, drawing in the air with it. In this way the two are thoroughly mixed; and if now they pass into the tube of the burner through a piece of gauze at its base, the burner is safe and trustworthy under all variations of pressure and quality of gas. To utilize the burner for heating purposes, the author proposed a stove six feet high and fifteen inches in diameter, with a partition dividing it vertically from the bottom to within six inches of the top. The burner is at the bottom of one division, and the outlet pipe at the bottom of the other.

Puluj has described a simple and easily constructed form of apparatus for determining as a lecture experiment the mechanical equivalent of heat. It consists of two truncated cones of cast iron, one of which is fixed, the other movable, revolving within the first

and in contact with it. The power consumed is measured by a kind of Prony brake arrangement, and the rise of temperature by a thermometer placed in mercury in the inner cone. The mean result given by fifty-seven experiments with this machine is 426.7 kilogramme-meters.

Puschl has investigated the fact, observed by Schmulewitsch, that caoutchouc when free dilates by heating, but that when stretched it contracts. From the theoretical consideration that the elasticity of a body increases with the temperature when at a maximum of density, and decreases when the density is a minimum, the author concludes that caoutchouc has a minimum density, the temperature of which diminishes as the tension increases. This temperature is above the ordinary temperature for caoutchouc without tension, the coefficient of dilatation being positive; it is inferior to the ordinary temperature for strongly stretched caoutchouc, the coefficient being negative.

Violle has experimentally investigated anew the question of the sun's temperature. He used a thermometer, carefully made, reading to one fifth of one degree, and blackened, placed within a copper sphere, also blackened. A second sphere of copper, externally polished, surrounds the first, the space between them being so arranged as to have a constant current of water of any desired temperature conveyed through it. On opposite sides of these concentric spheres are tubulures by which the solar radiation enters, closed by a plate having several openings of different sizes. His results, when reduced, show that every square centimeter of the earth's surface at the places named receives the number of units of heat (gramme-degrees Centigrade) placed opposite:

Summit of Mont Blanc	2.392
Grands Mulets	2.262
Glacier des Bossons	2.022
At the level of Paris	1.745

Assuming the correctness of Dulong and Petit's law, calculation from these numbers gives 1500° Centigrade as the temperature of the sun. But not desiring to assume this, Violle made direct experiments with his apparatus upon the heat radiated from Siemens-Martin steel when running into the moulds. From the data obtained he gives 1300° Centigrade as the temperature of the metal. This increases only a little the previous value; and after making all the allowances fairly demanded, the author maintains stoutly that the mean temperature of the sun does not sensibly differ from 2500° Centigrade.

Jannetaz has studied the propagation of heat in crystallized bodies in an ingenious manner. Instead of perforating the crystal plate, as has been done by previous experimenters, he used a small truncated

cone of platinum, having on each side of its base a platinum wire leading to the battery. The crystal plate is previously covered with some easily fusible substance (the author prefers lard), the little cone is brought upon its centre, and the circular or elliptical form of the liquefied portion of the covering material becomes very soon apparent. By this means Jannetaz has obtained some very curious results.

Maumené has communicated to the French Academy the results of his experiments on the temperature produced by mixing together olive-oil and concentrated sulphuric acid, in which he calls attention to the remarkable fact that the evolution of heat is greater if the acid has, just before use, been heated to ebullition. The same fact is true, he thinks, of other bodies having a high boiling-point. Such bodies by thus being heated suffer no proper chemical alteration, but undergo, apparently, a change in molecular structure, the evidence of which is a variation in the number of calories produced in their chemical actions. For example, fifty grammes of olive-oil mixed with ten cubic centimeters of acid recently boiled produce a rise of temperature of 42°. Using a specimen of acid two months old, of specific gravity 1.845, the rise was only 34.5° ; the same acid freshly distilled gave a rise of 44°.

Witz has experimented successfully with the freezing mixture suggested by Pierre and Puchot, *i. e.*, a mixture of hydrochloric acid and snow. He finds, for example, that 250 grammes of fine snow at zero mixed at once with 250 grammes of hydrochloric acid (commercial) of specific gravity 1.1823, at —1°, give in the course of one minute a solution having a temperature of —37.5°. If the acid be cooled previously to —18°, the mixture produces a cold sufficient to freeze mercury very readily.

Page has described a simple form of gas regulator, which has the especial advantage that it is not affected by variations in the barometric pressure. It consists of a mercurial thermometer, the stem of which is three sixteenths of an inch in inside diameter and open at the top. The gas is admitted through a fine tube which is placed within the thermometer tube, so that the rise of the mercury within this cuts off the supply of gas when the desired temperature is exceeded. This regulator kept a beaker of water for four or five hours within a range of 0.2° Centigrade, and kept the temperature of an incubator for six weeks within 0.5° Centigrade.

The intimate relation between the diffusion, the viscosity, and the conductibility of a gas on the mechanical theory of heat renders interesting some careful experiments of Kundt and Warburg upon the last two properties of gases above given. The results obtained give for the friction coefficient of air at 15° the number 0.000189, for hydrogen 0.0000923, and for carbon dioxide 0.000152. The value obtained for aqueous vapor was 0.0000975. The correspondence be-

tween these numbers obtained in a good vacuum and those of Graham and Maxwell at ordinary pressures, proves that this coefficient is independent of pressure. The coefficient of conductibility was determined from the time which a thermometer placed in the gas required to cool. At a certain limit of pressure the influence of convection disappeared, the cooling being due solely to radiation and conduction. By obtaining the most complete vacuum possible, they saw the rapidity of cooling become independent of the form of the vessel, and hence the conductibility is nil. In this way they showed the conductibility of hydrogen to be 7.1 times that of air, while that of carbon dioxide is 0.59. A curious fact observed was that the rapidity of cooling is by far the best test of the perfection of a vacuum.

Duclaux has observed and investigated the curious fact that a homogeneous liquid mixture may, by a change of temperature or by certain additions, become separated into two layers. For instance, a mixture of 15 cubic centimeters of amyl alcohol, 20 cubic centimeters of ordinary alcohol, and 32.9 cubic centimeters of water is homogeneous above 20°; but the least lowering of temperature below this, even by one tenth of a degree, causes the division of the liquid into two nearly equal layers. The author proposes to use this fact in the construction of an exceedingly delicate minimum thermometer. Convenient volumes of amyl and ethyl alcohols are mixed together, brought to the required temperature, and water gradually added, drop by drop, till a slight turbidity results. The liquid is then sealed in a tube, being first colored with carmine. Whenever the temperature falls below that at which it was prepared, the two layers appear, and of different tints. If methyl alcohol and ether be thus used, a maximum thermometer may thus be made.

Berthelot has given a system of classification of acids and bases founded on the decomposition of their salts by water, as shown by the thermal changes which result. In the first class are placed strong acids and bases. These, when separately dissolved in water and mixed in equal equivalents, produce an amount of heat which is nearly constant for all, and which is not increased by a new addition of water or of the base. Such salts, then, are not decomposed by water. The second class includes feeble acids. These form salts, even with strong bases, which are decomposable by water, the decomposition progressively increasing with the amount of water added. With some of the bodies of this class, however, the progress of the decomposition is gradual either up to a certain limit or indefinitely, while with others it is effected totally upon the first addition of the water. In the first class are placed chlorides, nitrates, and neutral sulphates of the fixed alkalies; in the second, the borates, carbonates, cyanides, sulphides, alkali-phenates, acetates, butyrates,

valerianates, as well as the alcoholates. The author thinks these results are due to the formation of hydrates of the acid and the base by the water added. In the first class the heat set free by the formation of the hydrates is less, in the second greater, than is evolved by the union of the acids and bases themselves.

The same chemist has examined thermo-chemically the explosion of gunpowder, in order to negative the view expressed by Noble and Abel, that this phenomenon is incapable of exact chemical formulation. He shows most clearly that when powder explodes there are formed all the bodies which are stable in the conditions of the experiment, principally potassium sulphide, sulphate, and carbonate, as well as carbon dioxide, monoxide, nitrogen, and steam. The proportions vary with the conditions of the experiments. These substances, if they remain in contact sufficiently long, suffer reciprocal action which brings them to a single condition, *i. e.*, that which corresponds to the maximum of heat set free. Each of these products is formed according to a regular law nevertheless, and the chemical transformations of the powder are expressed in all cases by a simultaneous system of very simple equations.

Julius Thomsen has published a memoir on the heat of neutralization of chemical substances, in which he gives the following conclusions: the differences observed in the results obtained disappear if the substances used be mixed in aqueous solution. The bases soluble in water are thermally divided into two groups: First, that of the hydrates, represented by potassium hydrate; and, second, that of the anhydrides, represented by ammonia, the typical heat of neutralization being for the first group for one molecule of normal sulphate 31,300 calories, and for the second group 28,200 calories, at 18°. For the insoluble bases only the apparent heat of neutralization can be measured, and this is the sum of the true neutralization heat and that of solution of the base. If the former be the same for the bases of the magnesia series (Mg, Mn, Fe, Ni, Co, Zn, Cu) as for the alkali earths, the heat of solution of these bodies will be negative, that of copper, for example, being —12,800 calories.

The radiometer continues to be the subject of extensive experimentation. Böttger, using a Geissler instrument, could not obtain the slightest rotation with the full moon or with phosphorescent tubes. A candle flame twenty-four centimeters distant, with an alum plate interposed, gave a weak rotation; but with a water cell no motion was detectible. If the instrument be placed in a room at 15° Centigrade, in presence of a gas flame, there is rotation as usual; but if immersed in water at 45°, the rotation is reversed. Lippmann has given a very complete list of the theories which have been advanced to explain the motion of this instrument, the general conclusion being that the energy effective is heat.

Neeson has experimented at length on the so-called mechanical

power of light as manifested in the apparatus of Crookes, and comes to the conclusion that the motions observed are due to heat currents produced in the residual air.

The University of Pennsylvania has recently obtained from Geissler one of Crookes' radiometers. It is extraordinarily delicate, the light of a candle three feet distant causing the vanes to revolve, and the rotation being continuous in ordinary daylight.

Von Wartha has made a series of experiments on the influence of pressure on combustion. For pressures greater than that of the atmosphere the experiments were made in the caisson of a bridge crossing the Danube at Buda-Pesth, the manometer there indicating 1.95 atmospheres. Six standard candles were burned for a definite time in the open air and then in the caisson, being weighed both before and after each experiment. The result showed the consumption, as a maximum, to be 17.4 per cent. more combustible in air at the ordinary pressure. In a receiver exhausted to 90 mm. a candle burns with a scarcely visible flame, the cause of which the author believes to be the fact that, as the pressure diminishes, the temperature of dissociation constantly increases.

Cailletet has also published a paper on the influence exerted by pressure on combustion. His experiments were made with a hollow iron cylinder which would stand a pressure of 300 atmospheres, into which air could be compressed by pumps. The flame to be examined was placed in this tube, glasses being inserted in the sides through which it could be seen. A candle flame becomes at first brighter as the pressure increases, but soon smokes, the combustion being incomplete. In general, however, the author concludes that the temperature of combustion increases with the pressure.

Heumann has published in full his memoir on the theory of luminous flames, in which the results of an extended investigation are given. He maintains that there are three separate causes which may destroy the luminosity of gas—subtraction of heat, dilution of the gas, and oxidation of the illuminants. Those hydrocarbon flames which lose their luminosity by cooling them recover it again when they are heated. Those which lose it by dilution with air or with indifferent gases recover it by raising the temperature of the flame. Those flames which lose their brightness by the moderate introduction of oxygen, which oxidizes the carbon directly, are made bright again upon diluting the oxygen.

Champion and Pellet have called attention to the resemblances which exist between the mode of decomposition of explosive bodies and the phenomena of supersaturation. They mention many respects, for example, in which a supersaturated solution of sodium sulphate resembles, in its instability and the means by which it solidifies, the explosive dynamite.

Magnier de la Source has experimented upon the solubility of uric

acid, and has discovered that the coefficient of solubility is a function not of the temperature at which it is determined, but of the maximum temperature which the mixture may have attained previously, and of the time which they have been in contact. Moreover, the solubility is also variable, since decomposition takes place. He concludes (1) that uric acid in solution has a variable solubility coefficient, which is the higher the more dilute the solution; (2) that this increase in solubility is due first to the production of a more soluble hydrate, and then to the dissociation of this hydrate into urea and dialuric acid; and (3) that this dissociation is facilitated by heat, especially in presence of potassium hydrate.

Weber has determined anew with great accuracy the specific heat of carbon, boron, and silicon by means of Bunsen's ice-calorimeter. If the specific heat of these bodies be taken at a temperature where they are constant, that of carbon is 0.467, silicon is 0.203, and boron is 0.500, thus bringing the atomic heats under the law of Dulong and Petit, as 5.6, 5.7, and 5.5 respectively. Three varieties of carbon were employed, their specific heat being the same at the temperature of 225°.

Schüller and Wartha have proposed some modifications in the ice-calorimeter of Bunsen, with a view of adapting it to more general use. The freshly fallen snow is replaced by ice, and the measurements are made by weighing the mercury expelled.

Naumann finds in the recent results of Kundt and Warburg upon the specific heat of mercury vapor a complete confirmation of the opinion which he, on purely theoretical grounds, expressed eight years ago, that mercury and cadmium molecules are diatomic. Moreover, he shows, in accordance with the dynamic theory of gases, that the heat of the atomic motion is to the heat of the molecular motion, and to the heat of expansion, as $n : 3 : 2$, in which n is the number of atoms in the molecule. The specific heats of gases, including that of mercury vapor, calculated on this hypothesis, agree well with those experimentally determined by Regnault and others.

Marié Davy has called attention to the agricultural value of meteorological observations. He gives the results of experiments made on growing wheat, in which the rate of transpiration was compared with the temperature and the actinometric power, and also gives statistics to show the connection between meteorology and crops. He believes that at the close of May or early in June, at which time the wheat is in flower, it is possible to deduce from purely meteorological data the value of the future crop.

Gernez has published in full his paper on the evaporation of superheated liquids. Having already shown that evaporation is the only normal mode of vaporization of liquids, he now considers the peculiarities of this mode of producing vapor.

OPTICS.

C. W. Siemens has exhibited at the Royal Institution some remarkable experiments on the action of light on the conductivity of crystallized selenium, mainly the results which had been obtained by Dr. Werner Siemens, of Berlin. He shows that cast selenium becomes more homogeneous and extraordinarily sensitive to light if it be kept for some time at or above 210° Centigrade. In this condition it may be used as a photometer, and is capable of giving accurate and constant results. Diffuse daylight doubles the conductivity, and direct sunlight increases it more than tenfold. A selenium "eye" was shown which had a selenium disk for the retina, and two slides for the eyelids. The eye was shown to be sensitive to white light, and also in different degrees to light of different colors. By means of an easily arranged electro-magnetic arrangement the current might be made to open and close the eyelids automatically. the selenium eye blinking by a flash of light exactly as does the natural one.

Lommel has given some ingenious and satisfactory demonstrations of certain optical problems not easily made evident without the higher mathematics, such, for example, as the angle of minimum deviation in prisms, achromatism, theory of the rainbow, etc.

Allard has investigated several questions of practical interest in light-house illumination, such as the transparency of flames and of the atmosphere, and the visibility of scintillating lights.

Rutherfurd has published a short account of his new glass circle for angle measurements. The circle is ten inches in diameter, and divided to ten minutes of arc. It is read by two micrometer microscopes magnifying seventy-five times. The probable error of a single reading is shown to be considerably less than half a second, while that of the mean of a series of such measurements is very much less. The author expresses his conviction that upon a fifteen-inch glass circle, provided with powerful microscopes, greater precision could be attained in the reading of angles than with the largest metallic circles now in use.

Krüss has studied the question of the depth of the images in optical instruments, and has given the results of the application of his principles to the human eye.

Abney has investigated the conditions of photographic irradiation —which causes the photographic image of a luminous body in front of a dark background to appear larger than it is—and concludes that the current theory that it is due to reflection from the back of the plate can only be true when the incident rays make an angle with the normal to the surface. This he conceives to be the fact, the particles of silver bromiodide scattered through the collodion film acting to reflect the light thus obliquely. The ex-

perimental results given accord well with those calculated on this theory.

Terquem and Trannin have described a new method for determining rapidly the index of refraction of a liquid, which, like Wollaston's, depends upon the angle of total reflection, but which does not require a special apparatus. By means of two plane parallel plates of glass, having a film of air between them, which are immersed in the liquid to be examined, the critical angle is determined, and so the index.

Hagenbach has called attention to the fact that unannealed or imperfectly annealed glass, which is in a state of tension from too rapid cooling, is very likely to break either from a blow or from sudden changes of temperature. As this tension renders the glass doubly refracting, he proposes to examine glass articles with polarized light in order to detect any imperfection in the annealing.

Gaumet has devised a new telemeter, or distance measurer, which is small enough to be carried in the pocket, and which gives the distances it measures to within one fiftieth of their actual value. Even this may be exceeded by using an observing telescope. It is founded on doubly reflecting the object from two mirrors placed at 45° from each other, one of which is movable. By means of a base-line, and the angle formed by the lines drawn from the distant object to the extremities of the base-line, the distance may be calculated.

Salet has investigated anew the question of spectra of different orders. He combats the view of Schuster that nitrogen ceases to give the characteristic channeled spectrum after being heated with sodium, and shows, first, that the spectrum in question can be obtained from nitrogen heated in contact with sodium; second, that the disappearance of this spectrum in the experiment is due to the disappearance of the nitrogen itself, it being absorbed by the sodium under the influence of the electric discharge; and, third, that the spectrum described by Schuster is really due to vapors of the alkali-metal.

Potier has examined mathematically the question of the influence which the motion of matter exerts upon luminous ether waves.

Salet has examined the spectrum of nitrogen and of the alkali metals in Geissler tubes. He observed that sodium sealed with nitrogen in a tube under a slight pressure did not always cause the disappearance of the bands in the nitrogen spectrum, but that it appeared even to absorb the nitrogen and to become black. This nitride, treated with water, gave the reactions of ammonia. In his opinion, therefore, the bands in the nitrogen spectrum are not changed when treated with sodium, unless the nitrogen is actually absorbed by the sodium, when the spectrum changes, of course, to that of sodium vapor, which was the spectrum supposed by Schuster to be that of nitrogen.

H. Vogel has published additional facts concerning the effect of certain coloring matters upon the sensitiveness of silver bromide to different portions of the spectrum. He finds, for example, that a dilute solution of methylrosaniline picrate increases powerfully this sensitiveness for the red rays between B and C. He says (1) that pure silver bromide is sensitive even to the ultra-red rays; (2) that to the substances already enumerated as increasing the sensitiveness of the bromide for special parts of the spectrum must be added methyl violet and cyanin, the latter increasing it for the orange rays; (3) that it is better to flow the alcoholic solution of the coloring matter on the collodion; and (4) that too strong a solution is to be avoided.

Vogel has also made an examination of the absorption spectra of several salts of the iron group of metals, and has drawn the characteristic absorption curves which belong to them, with a view to utilize the spectro-analytic method in qualitative analysis. By this means he has detected permanganate in a layer one and a half centimeters thick of a solution which contained only $\frac{1}{250000}$ part.

The same author has given the results of his examination of the spectra of various coloring matters, with especial reference to their use for detecting these substances when used for adulterations, especially in wines. These substances are very numerous, not less than 482 having been mentioned for this purpose at the recent Wine Congress in Colmar. Vogel uses a common pocket spectroscope, a few test tubes, and some simple reagents. Upon a horizontal line as the axis of abscissas he erects perpendiculars at the positions of the Fraunhofer lines, and then, by means of ordinates proportional to the intensity of color at different points, he obtains a simple intensity curve by which the results may be very readily compared. Figures of many of these curves are given in the paper.

Sauer has experimented upon the visibility of the ultra-violet rays of the spectrum. He used for this purpose light emitted by zinc in the electric arc, which he observed was particularly rich in these rays. He thinks there would be no great difficulty in using this method for obtaining a photograph of this portion of the spectrum.

Lockyer has made some remarkable observations on the spectrum of calcium at different temperatures and under different conditions. The blue line ordinarily observed in the calcium spectrum given with a Bunsen burner he considers a line of calcium itself, the other lines being those of its chloride, not dissociated. As the dissociation advances by rise of temperature, the blue line becomes more brilliant and the chloride spectrum fades. If now the electric arc be employed, the blue line is intense, and two new lines appear in the violet which occupy the position of the two H lines in the sun spectrum. But while in this spectrum the blue line is the most in-

tense, the reverse is the case in the solar spectrum. Using, however, a large induction coil and battery, and then a small coil and battery, Lockyer found that while in the latter case (the spectra being photographed) the blue line only was apparent, in the former the violet lines appeared, with no trace of the blue one. Varying the intensity of the current, a fac-simile of the three lines in the sun spectrum was obtained. The author queries whether these facts do not teach the dissociation of calcium itself, and suggests solving the problem by photographing the H lines of stellar spectra.

Delachanal and Mermet have given some results obtained by means of their spectro-electric tube which show its value in qualitative analysis. In the ashes of the sporules of the common puff-ball (*Lycoperdon pratense*), after separation of the silica, lines of sodium, calcium, magnesium, zinc, copper, and hydrogen were observed. A specimen of zinc examined in this way showed the presence of both indium and gallium. The estimated amount of indium in ten kilogrammes of the zinc was 0.050 gramme, and of the gallium 0.002 gramme.

Berthelot has re-examined the question of the rotatory power of styrolene, which he had asserted, but which had been denied by Van't Hoff. He finds that the value of $(\alpha^{s}) = -3.1°$ in one specimen and $-3.4°$ in another. The difference appears to be due to the presence of a little inactive styrolene.

Wunder has investigated the absorption spectra given by light reflected from different varieties of ultramarine, and gives curves showing the variation of intensity.

Mach and Merten have studied the effect of pressure upon quartz, and have shown that the velocity of light in the quartz may be changed by compression, the optical elasticity being lessened in the direction of the pressure, but much more in a direction perpendicular to this. Quartz may therefore be looked upon, say the authors, as an isotropic medium which has been subjected to an enormous pressure during crystallization, perpendicular to the axis, thus developing its double refraction.

Bosanquet has contrived a new form of polariscope, with which he has studied particularly the polarization of the sky. The essential part of the instrument consists of two quartz wedges, one of which is right-handed, the other left-handed. The terminal faces are cut at right angles to the axis, and the inclined common surface of the wedges makes an angle of about thirty degrees with the direction of the axis, which is also the line of vision. The quartz parallelopipedon is mounted in a tube having at the eye end a Nicol prism. The author claims for it certain advantages over the Savart polariscope, and gives some of the results he has obtained with it in studying the polarization of the sky.

Soret and Sarazin have made a series of measurements to ascertain

the rotatory power of quartz upon ultra-violet light, in which they used very successfully the new fluorescent eye-piece for the spectroscope recently devised by Soret. They succeeded in measuring the rotation of rays as far as the line N, and found that it increased from 51.22 at H to 55.88 at L, 59.03 at M, and 64.41 at N. The theoretical values calculated from Boltzmann's formula agreed well with these. Subsequently Croullebois has stated that he had made similar measurements, extending as far as the line O.

Nipher has communicated to *Nature* some ingenious optical experiments, essentially physiological in character. Roll up a sheet of paper, look through it, with one eye focused on some object beyond. On placing the hand by the side of the distant end of the tube, it will seem as if the hand were perforated and the sides of the tube transparent. If a drop of ink be placed on the hand, it will appear in the inside of the tube, but the hand itself will be invisible. This tube arrangement, used with both eyes, is excellent for viewing complementary colors.

ELECTRICITY.

Sandoz has examined four of the new Jamin permanent magnets of laminated steel with a view to ascertain whether their force varied with time whether the armature was attached or not, and also whether sudden rupture diminished the portative force. The magnet employed weighed 411 grammes, and its armature 69 grammes. Its maximum lifting power was 9.3 kilogrammes, or nearly twenty-three times its own weight. He finds that these magnets gain rather than lose by time, and that whether they are kept armed or not; and sudden rupture rather increases their power to receive charges.

Camacho has described a new form of electro-magnet, in which, instead of a bar of iron, the core is made up of a number of concentric tubes of iron, around each of which a coil of wire is wound. In one experiment such a magnet, charged with the same battery, lifted five times the weight which was raised by a precisely similar magnet constructed on the old plan. In a subsequent paper Du Moncel has communicated to the Academy some results he obtained with this magnet, which are analogous to those made by him in 1862. He shows that the increased power obtained in these magnets is due to a superposition of the magnetic effects by the enveloping cores.

Jamin has re-observed and extended the curious fact stated by Haldat that iron filings, inclosed in a brass tube and compressed, retain their magnetism permanently. Tubes thus made were shown the Academy, eight or ten centimeters long and three in diameter, which attracted iron filings at least as strongly as steel bars of good quality of the same size. Filings of pure soft iron showed the same result, as also did iron reduced by hydrogen.

Jamin has published an extended paper on magnetism, in which he gives the laws of magnetic distribution.

Duter has studied the distribution of magnetism in circular and elliptic steel plates, and concludes, 1st, the free magnetism is proportional to the surfaces; 2d, it is distributed in hyperbolic lines, the non-transverse axes of which are in the direction of the axes of symmetry perpendicular to the neutral line.

Gaugain, in a paper on the processes of magnetization, has stated that when two magnets have their contrary poles placed in contact with a bar near one of its ends, their action to develop magnetism temporarily at the middle point of the bar is very unequal, while the permanent magnetism thus produced is stronger at this middle point when but a single magnet is used. He gives theoretical considerations in explanation of these phenomena.

Gaugain has also studied the influence of the temper of steel upon its magnetization. As a result of his experiments, he concludes that those bars which have received the hardest temper are those which take the strongest magnetization when powerful means are employed to develop it, but that annealed bars are magnetized more strongly by means which are less energetic.

Favé has experimented on the action of heat on the magnetism of steel bars, with special reference to the observation of Jamin that steel is capable of receiving a considerable magnetism at a temperature at which it loses entirely all magnetism which it has received when cold. He finds, 1st, that the magnetism of a bar may be preserved at any temperature whatever, if this temperature be maintained constant; 2d, that the diminution of the magnetism, at first slow, becomes very rapid at the end of a time varying with the temperature of magnetization; and, 3d, the magnetism which remains after cooling, increases again upon heating the magnet.

Cazin has sought to establish a relation between the heat produced by the magnetization and the demagnetization of iron, the amount of magnetism alternately lost or gained by the core and the position of the poles, and in this way to get an approximate value for the magnetic equivalent of heat.

Duchemin has proposed the use of nickel for the protection of the needles of marine compasses against rust, and he gives the results of some experiments in this direction, made with his circular compass, which were entirely satisfactory. The deposit of nickel does not seem to affect appreciably the magnetization.

Deprez has made some experiments on the velocity of magnetization and demagnetization of iron, and finds that soft iron, ordinary iron, malleable cast iron, and chilled steel all required one and a half thousandths of a second for magnetization, and one four-thousandth for demagnetization. Gray cast iron was magnetized in one thousandth.

Rowland has published the results of his studies on magnetic distribution, giving the results of experiments made in 1870–71.

Bleekrode has investigated somewhat exhaustively the question of the use of ebonite plates in electric induction machines in place of glass ones. He maintains that even in ordinary machines they are far preferable, but that in double machines, such as the one devised by him, they are the only kind to be used. Moreover, they have important theoretical advantages in addition.

Warren de la Rue and Muller have described the method of construction of their new intensity battery, consisting of 3240 cells. This battery is composed of plates of chloride of silver and of zinc, excited by a solution of sodium or ammonium chloride—a form devised by De la Rue in 1868. The electro-motive force of this combination is to that of the Daniell cell as 1.03 to 1; the mean resistance of the entire battery is for each cell 33.5 ohms. It evolves from acidulated water (1 volume sulphuric acid and 8 of water), in a voltameter having a resistance of 11 ohms, 214 cubic centimeters of mixed gases per minute. The length of the spark in air, given by one series of 1080 cells, was 0.098 millimeter; with two such series, 0.629 millimeter; and with three, 1.623 millimeters; being directly as the square of the number of the elements used. In a subsequent paper the luminous effects produced by this spark in vacuum tubes are described, the striking distance being six decimeters.

Von Waltenhofen has described a new form of magneto-electric machine recently constructed by Siemens and Halske. It consists of steel magnets for producing the field, the peculiarity of which consists in their form and arrangement, which is like two V's, thus ◇, in the space between which a Siemens-Alteneck armature revolves. The machine is easily turned by hand, and with one rotation a second gave the electro-motive force of three Bunsen cells, and with three rotations one of eight. It heated to whiteness 30 cm. of platinum wire $\frac{1}{3}$ mm. thick, worked an induction coil, decomposed water, etc. Tisley has also devised an improvement in the breakpiece of the Siemens armature, by which the effects are increased.

Tresca has given the results of some experiments with the Gramme machine, made with great care to determine the economic value of this machine for the production of light. Two machines were employed, one of about six times the power of the other. The number of candle-powers obtained from the first was 12,950; the consumption of power, 7.68 horse-powers, or 1686 candles to the horse-power. From the second and smaller machine the light was equal to 2114 candles; and the power consumed was equal to 2.81 horse-powers, being 752 candles to the horse-power, thus showing the greater economy of the larger machine. The cost of the illu-

mination by the larger machine was only one hundredth of that of the same light when obtained with oil, and only one fiftieth of that obtained with coal gas.

Some experiments have been made in Paris upon dividing the electric light, under the direction of M. Baron. A single Gramme machine has fed in this way not less than eighteen lamps, each of which gave a light equal to 100 gas jets.

Mouton has proposed a simplified method of determining the internal resistance of a battery without complicated apparatus and the sacrifice of much time. It gives the resistance in terms of that of a certain shunt wire introduced into the circuit.

Planté has continued his experiments with secondary batteries, and now shows that the spark taken from the surface of water gives phenomena analogous to those observed in polar auroras.

Bourbouze has proposed to use natural conductors, such as water-courses, and even the earth, as a medium through which to obtain electric signals. Experiments which he has made in Paris seem to have been quite successful.

Girouard has described a new form of regulator for the electric light, the essential point of which is the use of a balanced arm separate from the carbon holder, and acting as a relay, through the magnet of which the whole current passes. The current of a small battery contained in its base is sent in one direction or the other, according as the electro-magnet is weak or strong, and this determines the motion of the clock-work by which the carbon points are separated or brought together. This balanced regulator has been used in the United States for many years by Farmer.

Holtz has described a new form of tube for electrical illumination, which is an improvement upon the one devised by Gaugain, in which a series of funnels directs the discharge. In the new tube there are one, two, or three diaphragms, in each of which are two funnel tubes facing opposite ways, those facing each way being on a right line parallel to the axis of the tube. The effect is the same as in Gaugain's tube, but the single tube is much more convenient.

Oberbeck has given a new method of measuring the electric conductivity of liquids. It consists in measuring the maximum striking distance between two balls of a given induction spark, and then introducing as a lateral circuit the liquid to be measured, and again measuring the spark. By making a series of observations and plotting them, taking the lengths of the liquid columns as abscissas and the spark length as ordinates, a curve of conductivities is very readily obtained.

Rowland has called attention to an error in Kohlrausch's determination of the absolute value of the Siemens mercury unit of electrical resistance, which he thinks will account for the two per cent. difference from the results of the British Association commit-

tee. This error consists principally in the omission from his equations of the coefficient of self-induction. Stoletow, in a subsequent note, while admitting that the error exists, and that its correction will tend to approximate the results, clearly shows that the error is entirely too small to extinguish the two per cent.

Wilson has contrived an ingenious method of attaching a mirror to a galvanometer needle so that the angular motion of the beam of light reflected from it shall be the same as that of the needle. For this purpose the light passes vertically upward to the mirror, which is fastened directly below the needle, and at an angle of 45° to its plane of oscillation.

Edlund has observed a fact of great importance to his theory of electricity, *i. e.*, the fact that the resistance of a conductor varies with the motion of this conductor, being lessened when the conductor and the current move in the same direction, and increased when the directions of the motion are opposite. In Edlund's theory, in which electricity is only the flow of ether through bodies, the strength of the current is measured by the mass of the ether which flows through the cross-section of the conductor in a unit of time.

Fuchs has proposed to use the electrometer as an instrument for measuring current strength, polarization, and resistance. In his experiments he employed a gold-leaf electrometer in communication with a dry pile. By combining this with the compensation method of Poggendorff, the results were satisfactory.

Fleming has made additional experiments to prove the position assumed in his paper read at the British Association and objected to by Rowland, *i. e.*, that the electro-motive force developed by the motion of an electrolyte through a strong magnetic field effects the decomposition of this electrolyte. He now shows that the facility of polarization of the plates is unaffected by the aeration of the liquid, and that the cause of this polarization can be removed from the plates mechanically.

Becquerel has published an important paper on the determination of the chemical force exerted by two solutions upon each other by means of the electro-motive force developed. The method is suggestive, especially in its physiological relations, since the strength and direction of the electro-motive forces in living beings are the foundations upon which rest not only all the phenomena of nutrition, but also those of life itself.

Dufet has experimented upon the electric conductivity of pyrite. He finds that this constant is very variable with different specimens, owing, undoubtedly, to want of homogeneity in them. While crystals from Traversella had a resistance varying from 750 to 4000 times that of mercury, those from Deville, more homogeneous, had a resistance only seventy-five times that of this metal. The results obtained show also that in a given crystal the resistance is constant

and independent of the direction, duration, or strength of the current.

Oberbeck has experimentally determined the resistance which the air offers to an induction spark. He shows that it is a function of the strength of the currents, and that hence its numerical value may be calculated in the same way as that of solid or liquid conductors.

Bauermann communicates a method of showing the conductivity of the various forms of carbon, due to Dr. Von Kobell, of Munich. A fragment of the carbon to be tested is held in a pair of zinc tongs (a simple strip bent on itself) and immersed in copper sulphate solution. The proportion of copper deposited on the carbon indicates its conducting power.

Lippman notes the curious experiment of putting a mass of water contained in a glass vessel in communication with the earth, and then bringing near it an excited rod of resin; oxygen is evolved at the wire. On removing it the hydrogen is disengaged. But before removing the rod, where was the hydrogen? The author says it is neither in combination nor solution, but is retained upon the surface of the water.

Buff has made an extended investigation into the changes of temperature which are produced when an electric current passes from one metal to another. The evolution of heat is proportional to the quantity of electricity passing in a unit of time multiplied by the electro-motive force of the battery.

Lovering has proposed an ingenious method of determining the velocity of electricity by means of two electro-magnetic forks vibrating at right angles and giving Lissajous' curves. If known resistances be introduced in the circuit of one of the forks, the change in phase will indicate the retardation of the current and give the data for the calculation.

Deprez has contrived a new form of electro-magnetic register for recording velocities. With the apparatus figured, which is simple in its construction, 600 complete signals can be recorded in a second.

Bichat has published an interesting memoir upon induction, in which he shows that as a current of high electro-motive force may be developed from one of low by means of the so-called induction coil, so, by passing a current of high tension from a Holtz machine through the outer coil, a current is generated in the inner coil capable of producing magnetic effects and of decomposing water, precisely as does the direct current from a battery. He also suggests an important modification in the Foucault interrupter, by which the intermittent current is interrupted more uniformly.

Weber has communicated an extended paper on the theory of the galvanometer, in which he discusses the whole subject mathematically.

Bunsen has given some results obtained in his laboratory by Hillebrand and Norton on the electrolytic preparation of the metals contained in the mineral cerite. About forty grammes of the elements cerium, lanthanum, and didymium were obtained in this way.

Kerr has been led from theoretical considerations to the discovery of a new relation between electricity and light. He has proved that dielectrified media are doubly refractive during the charge. The media employed were glass, resin, and quartz. The results prove that dielectrified resin acts as if extended along the lines of force, while dielectrified glass and quartz act upon the transmitted light as if they were compressed along the lines of force.

Colladon has published an extended research on the effect of lightning on trees, in which he gives the results of investigations on poplars, oaks, elms, pears, firs, grape-vines, chestnuts, and walnuts. The conductivity of poplar, he observes, is such as to make it of service as a lightning-rod, and he recommends connecting the base of these and of other tall trees with permanently moist earth—if possible a watercourse—by means of a metallic rod.

Schaack has given in a recent memoir his views upon the construction of lightning-arresters at present used for telegraph lines. He proposes to replace these by a simple trough of water, made of metal and connected to earth, through which the wire (a fine spiral of silk-wound German-silver wire covered with a thin coating of rubber) which connects the register with the line passes. The earth connection from the register is made to the metal of this trough. A discharge of lightning would melt the small wire and escape to earth, leaving the instruments uninjured.

CHEMISTRY.

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In *General Chemistry*, Cayley has communicated to the Chemical Section of the British Association a paper on the analytical figures which are called trees in mathematics, and on their application to the theory of chemical compounds. His purpose was to determine the theoretical number of hydrocarbons of the formula C_nH_{2n+2}, and his results agree with those of experiment so far as the latter have been developed. He shows, for example, that 799 isomers are possible, having the formula $C_{13}H_{28}$.

Berthelot has continued his studies in thermo-chemistry, and has published two papers. In the first of these he treats of the thermal changes connected with the oxides of nitrogen; in the second, of the thermic formation of barium dioxide and hydrogen dioxide.

Muir has given his views of the present system of chemical notation and its complete significance, arguing that its symbols actually do mean far more than they are usually made to in ordinary usage, and hence that the newer dynamical views now arising may find it best to retain them.

Janovsky has published a paper on equivalence, in which he maintains with good reason that the only rational basis for this property of atoms, as well as for the correlative one of combining weight, is to be found in the dynamical theory of work.

During the month of April a national chemical society, with the title of the American Chemical Society, was organized in New York. The objects of this body are the encouragement and advancement of chemistry in all its branches, in furtherance of which monthly meetings will be held in New York, and an annual meeting at some selected place. The society starts with a membership of 133, under the presidency of Professor J. W. Draper.

Mills has published an important paper on "The First Principles of Chemistry," in which he places in a strong light the dynamic theory of chemistry in distinction from the statical theory now generally received.

Lodge has given an interesting discussion on nodes and loops in connection with chemical formulas, showing that the number of each may be easily calculated in any given case.

Ostwald has experimented to determine the effect of mass in the chemical action of water upon other bodies. He used a solution of

bismuth chloride, to which various quantities of water were added, the amount being in all cases more than enough to produce the precipitate. These precipitates were analyzed, and the ratios of the chlorine and bismuth determined. From them a curve was constructed, which is hyperbolic along two thirds, and straight for the other third of its length. Hence the author believes Bertholiet's law is true, the action being proportional to the mass, the curve being due to external influences.

INORGANIC CHEMISTRY.

Pierre and Puchot have obtained a crystallized hydrate of hydrochloric acid by cooling a saturated solution of the gas in water to —21° or —22° Centigrade, a current of this gas being maintained through it. As soon as crystallization begins, the temperature rises to —18°, and remains there so long as crystals form. Synthetical calculation as well as analysis fixed the formula of the crystals as $HCl(H_2O)_2$. The authors hence recommend a mixture of hydrochloric acid and snow as a freezing mixture.

Berthelot has studied the thermic conditions attending the formation of ozone. He finds that in the production of one molecule of ozone from oxygen there is an absorption of 29.6 calories. Being therefore a body formed with the absorption of heat, its activity chemically is accounted for; it is a magazine of energy stored up under the influence of electricity.

Frankland has published a paper on water analysis, in which he examines the value of the albuminoid-ammonia process, and concludes that it is "entirely useless in the examination of waters for sanitary purposes." He claims, however, for the combustion process, that it is the only one which gives trustworthy information concerning the organic matter present, the only one which can determine the carbon, and the only one which shows the ratio of nitrogen and carbon.

Gladstone and Tribe have shown that water may be decomposed by the joint action of aluminum and aluminum iodide, bromide, or chloride. They suggest as probable that the reaction takes place in two stages. In the first the aluminum of the iodide is oxidized, and in the second it is regenerated, setting free hydrogen.

Precht and Kraut have published the results of experiments made to test the statement of Debray that the tension of aqueous vapor which is given by a salt containing crystal-water in a vacuum is dependent solely upon the temperature, and hence that this tension may be made use of to ascertain whether all the molecules of this water of crystallization are held with equal force. Their conclusion is that while in individual cases this may be done, it can only be considered reliable when all the collateral circumstances are taken into the account.

Weber has discovered a new compound of sulphur and oxygen, which has the formula S_2O_3, and which he calls sulphur sesquioxide or dithionic oxide. It is prepared by acting on sulphuric oxide, containing a trace of sulphuric acid, with sulphur. A dark blue compound separates in liquid drops, falls to the bottom, and solidifies in crystalline crusts. Below 15° Centigrade it is sufficiently permanent to be weighed. Selenium forms a similar compound, containing both oxygen and sulphur.

Behrend has described a new method of preparing sulphuryl chloride, which consists in heating sulphuric chlorhydrin in sealed tubes to 170°–180° for ten to fourteen hours. The yield is satisfactory.

Scheurer-Kestner has examined the gas which is produced by the combustion of pyrite, in reply to Bode. The sulphurous oxide varies from 6 to 9 per cent., the oxygen from 6 to 9 per cent., and the nitrogen from 84 to 85.5 per cent.

Olivier has given an elaborate paper descriptive of the sodium nitrate regions of South America, illustrated with an excellent map of the region.

Friedburg has proposed the use of fuming nitric acid for removing the last traces of impurity from carbon disulphide. The two are distilled together; the distillate is washed and rectified.

Nilson has made an elaborate investigation of the arsenic sulphides, by which he has thrown much light on the modes of formation and the reactions of these bodies.

Champion and Pellet have investigated the conditions of the decomposition of nitrogen iodide and chloride. Since both chlorine and bromine displace iodine from its combinations, it is natural to infer that these bodies will decompose nitrogen iodide. It is decomposed with explosion when placed at the end of a tube in which chlorine is being evolved, or in the vicinity of a rod moistened with bromine. The temperature at which the iodide detonates is 48° Centigrade. Notwithstanding Abel's opinion of its inconstant composition, the authors believe it to be uniform when made by placing one gramme iodine in 10 c. c. ammonia, agitating, allowing to stand ten minutes, filtering off, washing twice with 10 c. c. ammonia, and then with water. It is placed on gelatin paper, and covered with goldbeater's skin gummed down while still moist. On drying, the skin contracts and holds it fast. As to the chloride, the authors attribute its explosion in contact with turpentine to the attraction which this oil has for chlorine, and the ease with which it gives up its hydrogen. This view is strengthened by the fact that, when saturated with chlorine, the turpentine does not explode the chloride.

Acworth has examined the action of nitric acid upon copper, mercury, silver, etc., with a view to determine the gaseous products. He finds (*a*) that copper acted on by cold dilute nitric acid evolves

a gas containing ninety to ninety-five per cent. nitrogen dioxide; (*b*) the same action in presence of a strong solution of copper nitrate evolves a gas containing eighty-five per cent. nitrogen monoxide; (*c*) potassic nitrate has no influence, but ammonium nitrate causes the evolution of nitrogen and nitrogen monoxide, with some dioxide; (*d*) mercury, zinc, and iron, in presence of ammonium nitrate, give rise to the evolution of nearly pure nitrogen; (*e*) silver alone with nitric acid gives chiefly nitrogen dioxide and nitrogen. With ammonium nitrate the gas evolved is chiefly nitrogen.

Storer has called attention to the almost universal occurrence of minute quantities of ammonia in the ordinary chemicals of commerce, the sulphuric acid examined affording from 0.07 to 0.16 of a milligramme in five cubic centimeters.

Meusel has proposed to account for the occurrence of nitrites in spring waters, not as is usually the case by supposing the oxidation of ammonia therein, but by supposing the reduction of the nitrates in the water through the agency of bacteria. He shows (1) that spring waters which contained bacteria and nitrates, but no ammonia or nitrites, showed the nitrous acid reaction on standing four days; (2) that the production of nitrites in this way is stopped by antiseptics; (3) that aqueduct water containing nitrates produces no nitrites, even in presence of bacteria, unless a carbohydrate be present; (4) that distilled water containing both glucose and nitrates can not be made to generate nitrites if bacteria be absent; and (5) that decomposing albuminates reduce nitrates to nitrites.

Spirgatis has given some facts which appear to prove the existence of arsenic in antique bronzes. Four bronzes were analyzed, two of them earlier than the Christian era, the other two of the fourteenth and fifteenth centuries. Of the earlier ones one contained 0.12 and the other 3.52 per cent. of arsenic; of the later the quantities were 0.96 and 0.32 per cent. respectively.

Gautier has given an improved method of quantitative testing for arsenic in cases of poisoning. The organic matter is destroyed by alternate treatment with strong nitric and strong sulphuric acids, the sulphide precipitated as usual, converted into oxide, and placed in a modified form of Marsh apparatus, by which the whole is collected in a tube and weighed.

Jones has made a somewhat extensive research on stibine, with a view to determine its exact composition. Taking the fact, discovered in the progress of the work, that stibine passed over sulphur is decomposed, yielding antimony sulphide and hydrogen sulphide, as the basis of a quantitative method, he proves this stibine to be SbH_3.

Suilliot finds that borax is not the excellent antiseptic that has been claimed, though it is equal in this regard to salt. But he gives the results of some experiments with calcium borate, which seem to show that this salt has antiseptic powers of considerable value. He

believes that by the action of the meat the salt is decomposed, yielding a simple borate, which preserves from decomposition, while the boric acid thus set free preserves it from mould.

Troost and Hautefeuille have observed that when boron chloride is passed through a heated porcelain tube, silicon chloride and aluminum chloride are formed. Even pure silica and pure alumina are thus attacked. Silicon chloride does not attack porcelain, but is decomposed by alumina. Both chlorides attack zirconia and titanic oxide readily.

Hornberger has attempted to introduce zirconia into organic compounds, and has studied this earth at length. He concludes, first, that the similarity with silicon which is so striking in inorganic chemistry does not hold in organic; since, second, zirconia can not unite with alcohol radicals to form a sort of ether in which it plays the part of an acid; and, third, zirconia plays a decidedly positive part in organic compounds, this element replacing readily only acid hydrogen.

Moride has given some statistics of the production of charcoal from algæ on the French coast, which has risen to an important industry; 100,000 kilogrammes of the fresh plants yield 20,000 kilogrammes of the dried, and 5000 kilogrammes of charcoal. This, when incinerated, yields from 3500 to 4000 kilogrammes of saline matter, containing 20 per cent. of potassium salts. The charcoal itself is an excellent disinfectant and decolorizer, and is also used as a fertilizer.

Hartley has examined the liquid which is contained in the cavities of some varieties of rock-crystal, and comes to the conclusion that it is liquid carbon dioxide. Comparing his results with Brewster's, he adds to the list several other minerals. The proof of the fact stated he finds in the fact that the critical point for the inclosed liquid is between 30.75° and 31° Centigrade, while that of liquid carbon dioxide, as determined with great care by Andrews, is 30.92°.

Wright has examined several more meteorites for the purpose of determining their gaseous constituents, and finds essentially the same composition for these gases as that given by the Iowa meteorite before published. The present results, however, were obtained at temperatures varying from 350° Centigrade to a full red heat for the stony, and from 500° to a bright red heat for the iron meteorites. His previous generalization, that stony meteorites differ from iron ones in containing more carbon dioxide and less hydrogen and carbon monoxide, and in evolving their gaseous constituents at a much lower temperature, seems fully confirmed.

In a later paper Wright continues his studies upon the gases contained in meteorites, and gives the results of his examination of the Kold Bokkeveld meteorite, which, though stony, contains considerable carbon and some bituminous matters. It yielded 25.28 volumes

of gas, of which 93.11 per cent. was carbon dioxide, the remainder being carbon monoxide, marsh gas, hydrogen, and nitrogen, the two latter in minute quantity. It also yielded ten per cent. of water, in which chlorine and sulphurous oxide were detected. The question of the manner of occurrence of the gases within the meteorite is also discussed.

Remsen and Southworth have made the curious observation that carbon monoxide is not oxidized by ozone. The two were passed into a flask, and then through lime-water; but not a trace of turbidity was perceptible in the latter, even when the entire apparatus was placed in full sunlight. The authors discuss the bearing of this fact upon the question of free attractions in carbon monoxide.

Zöller has made a series of experiments upon the antiseptic and disinfecting properties of carbon disulphide, from which it appears that this substance is quite remarkable in this direction. Since it appears that mould and putrefaction can not take place in air containing a comparatively small quantity of this vapor, the author especially recommends such an atmosphere for preserving meat and other food during the process of transportation to the consumer.

Houzeau has given a new method for the volumetric determination of free carbonic acid, which consists in absorbing the gas in a titered solution of sodium hydrate, precipitating the carbonate in an insoluble form by a neutral solution of barium chloride, and then titering back with a graduated solution of sulphuric acid. To prevent the formation of sodium bicarbonate a small quantity of zinc oxide is dissolved in the soda solution before use.

Bong has described a new class of prussiates, obtained from the yellow prussiates in much the same way as the nitroprussiates, but using chloric acid in place of nitric. The potassium salt is black when solid. It dissolves readily in water, giving to it an intense violet color, but is almost insoluble in alcohol. With metallic salts, even with those of zinc, it gives dull green precipitates, more or less dark —a fact which distinguishes the new salt from the ferricyanide.

Godeffroy has redetermined with care the atomic weights of rubidium and cæsium. The metals were separated from each other and from potassium by crystallization as alums, the last traces of rubidium being removed from the cæsium salt by precipitation of the latter by means of antimonous chloride. As a mean of four closely accordant determinations, the atomic weight of cæsium obtained was 132.627, and that of rubidium 84.525.

The ammonia-soda process of Solvay has, according to German accounts, been lately so much improved as to threaten the abandonment of the standard method in Germany.

Guyard has examined the residue left in the retort after the manufacture of sodium. The mixture put in consisted of crude salt of soda, 56.5; coal, 18.5; coke, 10.5; chalk, 14.5. The residue, after ex-

posure to the air, consisted of 35 per cent. of soluble matter, 9 of water, 22 of carbon, 18 of carbonate and oxysulphide of calcium, ashes and iron oxide, 15.4. The soluble portion contained 11.9 caustic soda, 44.80 carbonate, 24.10 sulphate, 11.70 sulphite, 0.45 sulphide, 7.05 chloride of sodium, 0.2 silica, 0.3 of alumina, and traces of lime and potash.

Terreil has analyzed the black residue obtained by calcining potassium ferrocyanide, and finds it to consist of metallic iron, 32.05; magnetic oxide of iron, 27.56; uncombined carbon, 27.49; combined carbon, 1.17; carbon as cyanogen, 0.24; potassium, 0.81; nitrogen, 0.29; oxygen, 10.50.

Grünzweig and Hoffmann have conclusively sustained their statement of the crystalline character of ultramarine, against Büchner, who had maintained that the crystals observed under the microscope were those of quartz. They now bring forward the testimony of additional experts, who have seen and examined the crystals, and of Vogelsang, who has determined them to belong to the cubic system.

Gladstone has observed that the chemical activity of aluminum is greatly augmented by contact with a more negative metal, this substance decomposing water readily at 100° Centigrade when either copper or platinum was electrically deposited upon it. In connection with Tribe, Gladstone has also made some experiments upon the activity of pure zinc, as compared with zinc upon the surface of which copper has been deposited. From this it appears that even arsenical zinc, when covered with copper, may be boiled with water, and evolve large quantities of hydrogen without giving in this gas a trace of arsenic. The foil alone, treated with dilute sulphuric acid, gave abundance of arsenous hydride.

Gladstone and Tribe have also extended their researches to the decomposition of aluminum in presence of its haloid compounds, and have observed that alcohol is readily decomposed on heating with this metal and its iodide, evolving hydrogen and leaving aluminic ethylate in the retort. This latter body is a yellowish-white solid, which is capable of distillation.

Naumann shows that potassium-alum solutions, when heated to 100° Centigrade, are partially decomposed, losing a portion of their sulphuric acid.

Troost and Hautefeuille have described a manganese boride, and have studied elaborately the part which manganese plays in the metallurgy of iron, paying especial attention to the thermo-chemical reactions involved.

Parsons has made a series of experiments at the Woolwich Foundry on a manganese bronze, which, when forged, had a strength of twenty-nine tons to the square inch, an elastic limit of twelve tons, and an elongation of nearly thirty-two per cent.

Laspeyres has investigated the chemical constitution of the natural and artificial oxides of manganese, called braunsteins, with a view to determine the equivalence of the metal manganese.

Mermet has proposed a very delicate test for the so-called sulphocarbonates, now coming into extended use among grape-culturists as remedies for the phylloxera. If to an extremely dilute solution of a salt of nickel in ammonia a few drops of the solution to be tested be added, a characteristic currant-red color is developed. This test is extremely delicate, showing $\frac{1}{50000}$ or even $\frac{1}{80000}$ of sulpho-carbonate in a solution. Braun had proposed some time before the sulphocarbonate as a very delicate test for the presence of nickel.

Lecoq de Boisbaudran, the discoverer of the new element gallium, has given laboratory methods for the extraction of this metal from the blendes in which it occurs. A list of blendes is given, together with their relative values as sources of gallium. The best one is that called the black blende of Bensberg.

He has subsequently communicated additional facts concerning his new metal, gallium. He has prepared the metal itself electrolytically, and a piece of it weighing 3.4 milligrammes was presented to the Academy by M. Wurtz. The spectrum consists of only the two lines already mentioned, of wave lengths 417 and 403.2 respectively. He has succeeded finally in obtaining a grain and a half of the metal in the pure state, and has determined that it melts at 85.1° Fahr., so that it liquefies when held in the hand. Its specific gravity is 4.7, water being 1.

Guyard has thrown considerable light on the formation of aniline black by the discovery that the salts of vanadium have a marked influence in producing it. This he attributes to the facility with which this metal passes from one state of oxidation to another.

Bedson has made a series of experiments on compounds formed by the union of ether with certain chlorides of the metals. He has succeeded in forming such compounds with vanadium oxychloride and with titanium tetrachloride. Titanium trichlorhydrin is also formed.

Aronheim has suggested the use of molybdenum pentachloride as a most efficient chlorine carrier. While endeavoring to find a solvent for this substance, the fact appeared that even benzene when heated, after dissolving this body, evolved torrents of hydrochloric-acid gas. Further experiment proved its great superiority to iodine in this respect, because (1) it is more energetic and rapid, (2) carries the chlorinating more uniformly from one stage to the next, and (3) can be removed, after the reaction is finished, much more easily.

Terreil has communicated to the French Chemical Society the analysis of the magnetic platinum of Nischne-Tagilsk. The magnetic metals present are iron (8.18 per cent.) and nickel (0.75 per cent.). There is also given in the analysis 3.13 per cent. chrome iron.

De Souza has made a series of experiments to ascertain whether amalgams are actually chemical compounds. He maintained both silver and gold amalgams at the temperature of boiling sulphur until the weight remained constant, and then found that the former contained its constituents in quantities required by the formula $Ag_{13}Hg$, and the latter, Au_8Hg, thus confirming the theory of chemical union.

E. Dumas has written upon the touch-stone, giving an extended historical sketch of the subject, and furnishing an analysis of a stone which has been used from very ancient times in the Paris assay office. It proved to be a piece of fossil wood, of an unknown genus and species, however, to which, on microscopic data, Renault assigns the generic name *Obrussaxylon*, meaning wood used for assaying gold.

Sainte-Claire Deville and Debray have published some data concerning the density of pure platinum and pure iridium prepared with great care, and also that of several alloys of these metals. They find that the mean density of platinum, estimated from ingots weighing from 200 to 250 grammes, is 21.5. Iridium in the ingot has a density of 22.239; after breaking under the rolls, of 22.421. An alloy of 10 per cent. iridium has a density of 21.615; of 15, 21.618; of 33.33, 21.874; of 95, 22.384.

Scheurer-Kestner has communicated additional facts upon the corrosion of platinum stills which are used for the concentration of sulphuric acid. He finds (1) that the loss is not mechanical but chemical, the metal being contained in the acid in solution; (2) that when the acid is free from nitrous compounds, it dissolves about one gramme of platinum for every ton of sulphuric acid concentrated to 93–94 per cent., but six to seven grammes per ton when the concentration is pushed to 98° and above, rising even to nine grammes when the acid marks 99½ per cent.; (3) that the loss is even more considerable if nitrous products are present in the acid.

Boussingault has published a memoir upon the silicification of platinum and some other metals, showing that they do not unite with carbon at a red heat, that carbon reduces silicon at a high temperature, that platinum heated to whiteness in a silicious carbon crucible is silicified, and that the silicon is held by the carbonous oxide.

E. von Meyer has studied at length the apparent action of chemical attractions called into play during the slow oxidation of hydrogen and carbonous oxide by means of platinum.

Deville and Debray have observed that cyanide of potassium mixed with spongy platinum, and heated to 500° or 600° Centigrade in presence of aqueous vapor, evolves hydrogen, and forms potassio-platinum cyanide. The same is true of a concentrated solution of the cyanide. The authors show that this result flows necessarily from the thermal exchanges involved in the reaction.

Zarawkowitch proposes the use of glycerin for reducing platinum

solutions in order to form platinum black; 15 c. c. of glycerin of specific gravity 25° to 27° Baumé, and 10 c. c. potassium hydrate of density 1.08, are gently heated, and 3 to 5 c. c. of platinic chloride is added. The platinum black falls, and is collected and washed.

Meyer has described a lecture experiment for illustrating that vaporization without fusion is due to pressure. Two glass tubes containing iodine are prepared and sealed, one vacuous, the other at nearly the ordinary pressure. If now both tubes be warmed, the iodine in the second tube melts, and may be made to run down the walls of the tube; in the vacuous tube the iodine only volatilizes.

Landauer has proposed a very simple form of blow-pipe, which consists simply of two bottles tubulated at bottom, and connected by these tubulures through a rubber tube. The upper opening of one of these is closed by a cork, through which a tube passes going to the jet. This bottle being empty, the other bottle is filled with water and placed at a convenient height. The hydrostatic pressure forces the air out of the first and lower bottle through the jet.

Frerichs has devised a new form of balance, in which the beam is made of aluminum alloyed with five per cent. of silver. The beam is very short, and yet the balance is not at all deficient in delicacy. The use of riders is dispensed with, the small weights being determined by the torsion of a wire ingeniously arranged.

Arzberger proposes the use of an air-damping apparatus for chemical balances, to diminish their oscillations. To the stirrup a gilded brass plate is hung, which moves in a short cylinder, a trifle larger in diameter, supported on the case.

Drechsel has described a new form of wash-bottle, differing from the older forms by having the tubes ground into the neck of the flask, the delivery tube being enlarged for this purpose, while up through the top of this enlarged stopper comes the inlet tube. For washing with corrosive substances it may be useful.

Mohr has communicated a paper on the nature and origin of meteorites, in which he discusses at length the chemical and astronomical questions involved.

Houzeau has proposed a method for the volumetric determination of carbon dioxide, depending on the absorption of the gas by a graduated solution of alkali, precipitation by barium chloride, and estimation of the free alkali.

Dupré has proposed a modification in Dumas' method for the determination of nitrogen in organic analysis, which consists in a carbonic-gas apparatus by which the air and the nitrogen may be removed, and a peculiarly constructed cylinder for receiving and measuring the gas.

Johnson has observed the formation of nitrites in the potash bulbs when bodies containing nitrogen are burned, and as these absorb oxygen and increase in weight, they may cause an error.

Precht and Kraut have investigated at length the question of the dissociation of salts which contain water, and have obtained some valuable results.

Langley has proposed, in determining carbon in iron and steel, to burn the carbon without first separating it from the copper, as is the usual method.

A new test-paper, prepared by Waller, is made by soaking strips of unsized paper in a solution of corallin, and is said to be exceedingly sensitive to the presence of alkalies, turning a beautiful red color, while acids turn it yellow. Waller proposes it as an alkaline reagent in place of litmus.

ORGANIC CHEMISTRY.

In *Organic Chemistry*, Fittig's hypothesis that cumene was isopropylbenzene has been established by Jacobsen, who has succeeded in effecting its synthesis by acting with sodium on isopropyl iodide, resting upon which was an equivalent quantity of brombenzene dissolved in six times its volume of ether. The action proceeded slowly, and after four days was interrupted. On fractionating, a hydrocarbon boiling near 150° was obtained, which had all the properties of cumene.

Pinner has re-examined more carefully the new hydrocarbon which he announced to have the composition C_3H_2, and finds that this is wrong, owing to an error in the formula of dichlorallylene from which it came. Its true formula is C_3H_4, and it is hence either allylene itself or an isomer of it.

Butlerow has shown that the olefines, like the terpenes, are capable of direct union with water to form alcohols, isobutylene yielding trimethylcarbinol quite readily in this way.

De la Harpe and Van Dorp have examined the hydrocarbon fluorene discovered by Berthelot. They find that when fluorene is distilled over moderately heated lead oxide a semi-solid reddish product is obtained, which is a condensation product containing double the number of carbon atoms in its molecule.

Osipoff has succeeded in preparing amyl alcohols from the direct union of amylene and sulphuric acid. The two forms of the alcohol obtained are respectively dimethyl-ethylcarbinol and methyl-isopropylcarbinol, the quantities varying according to the concentration of the acid used.

Dr. Van Hamel Roos has examined carefully the condition under which glycerin crystallizes, having had fifty-six pounds of crystals to work with. The crystals are monoclinic. The only requisite in their production is the freedom of the glycerin from water. Crystals are the best test of purity, and also the best means of purification.

Renard has studied the action of electrolytic oxygen on glycerin, and finds that there is produced a glyceric aldehyde, which reduces

ammonio-silver nitrate, giving a brilliant mirror and also the copper test.

Girard has proposed to mix with dynamites, in order to prevent their congelation in cold weather—a result which seriously interferes with their explosive power—about ten per cent. of methyl nitrate. The volatility of this body he finds to be no inconvenience in practice.

Michaelis has succeeded in introducing arsenic into the aromatic series by acting upon arsenous chloride with mercury-diphenyl. A heavy, colorless, strongly refracting liquid was obtained, which was phenyl-arsenous chloride.

Sadtler has discovered the interesting fact that tartronic acid is a product of the direct oxidation of glycerine by nitric acid.

Kilmenko has studied the action of bromine on lactic acid, and finds that it yields ethyl bromide and a crystallized substance neutral in its reaction, and containing bromine, apparently formed by the direct union of bromal and lactide.

Kolbe has published a valuable paper entitled "Chemical Hints for the Practical Use of Salicylic Acid," of the synthesis of which substance he is the discoverer, and which has proved so efficacious as an antiseptic.

Bremer and Van't Hoff have examined the succinic acid obtained from active tartaric acid with a view to determine its optical action. According to the latter's view, no substance can rotate a polarized ray which does not contain one or more asymmetrical carbon atoms. Since succinic acid contains no such atom, it should not rotate such a ray; and the authors show that it does not.

Kupferberg has succeeded in effecting the retransformation of paraoxybenzoic acid into salicylic by heating its sodium salt to 290° Centigrade. Over one half of the theoretical yield was obtained.

Brunner and Brandenburg have succeeded in detecting succinic acid in the juice of unripe grapes. They were led to examine for it by the fact that nascent hydrogen, acting on ethyl oxalate, produced tartaric acid and glycolic acid. The same reduction process, the authors believe, therefore goes on in the plant.

Barth has investigated a product of the action of hydrochloric acid on resorcin observed by him some time ago. He finds it to be soluble in alkalies, and precipitable by acids in bright brown flocks, which on drying show a magnificent green metallic lustre, and by transmitted light are scarlet. It is an ether of resorcin.

Bindschedler and Busch have described the synthetic process by which the new red color, eosin, is produced artificially. As is well known, eosin is derived from fluorescein, which is a product of the action of phthalic acid on resorcin. The phthalic acid is readily prepared by the oxidation of naphthalene. The resorcin is produced by fusing the sodium salt of benzol-disulphonic acid with soda. Heating the resorcin and phthalic acid together gives fluorescein;

and treating this with bromine gives tetrabromfluorescein, of which eosin is the potassium salt. The price of eosin is 100 francs a kilogramme.

Weselsky has shown that phloroglucin is a very delicate test for nitrous acid. Very dilute solutions of phloroglucin and toluidine (or aniline) nitrate become dark orange on the addition of a few drops of a dilute solution of potassium nitrite, and a cinnabar red powder is thrown down.

Jacquemin has examined the methods proposed for the detection of fuchsin in wine, founded on its tinctorial power. As is well known, this substance is extensively used for this purpose. Pyroxylin and wool may be dyed directly in the wine, but to prove the presence of fuchsin finally, the ammonia process is necessary.

Liebermann and Fischer have further examined chrysophanic acid, the active principle of rhubarb. They find it to stand to emodin, its associate, precisely as alizarin stands to purpurin, only both the former are homologous with the latter, being derivatives of methylanthracene. Chrysophanic acid is dioxymethylanthraquinone.

Graebe and Caro have made an extended investigation of rosolic acid, restricting this name to the substance obtained by the action of nitrous acid on rosaniline and subsequent treatment with water. They find that it is capable of giving a series of tetra-substitution products, and is analogous, therefore, with the phthaleins of resorcin and orcin described by Baeyer. Reduction yields both hydrorosolic acid and leucorosolic acid, and from these come tetrabromleucorosolic acid and hydrocyantetrabromrosolic acid.

Hlasiwetz and Habermann have examined the chemical characters of gentisin and of gentisinic acid, into which and phloroglucin the former is decomposed. This acid by heat yields carbon dioxide and hydroquinone.

Butlerow has made some experiments with the milky juice of *Cynanchum acutum*, Linn. He finds in it a volatile alkaloid and a white gum-resin, probably a phenol, to which he gives the name cynanchol.

Williamson has described some metallic derivatives of coumarin, containing the metals sodium, potassium, barium, silver, and lead.

Wartha has investigated more minutely the coloring matter of litmus, and has shown that the commercial article always contains indigo. He gives directions for preparing the coloring matter pure.

Tiemann and Haarmann have described a method for the accurate determination of vanillin in vanilla, and have shown that the price of the commercial varieties is not always in accord with their content in vanillin.

Latour and Cazeneuve have separated from mahogany an astringent substance containing carbon, oxygen, and hydrogen, which is crystalline, and identical with catechin.

Prescott has given the results of his determinations of the solubilities of the alkaloids, in the crystalline, amorphous, and nascent conditions, in ether, chloroform, amyl alcohol, and benzine respectively, these solvents having been washed with water before use.

Hesse has communicated a preliminary note, in which he says he has found in a rare cusco bark an alkaloid which appears to agree with the cusconine of Leverköhn, and to be closely allied to the aricine of Howard.

Glenard has investigated the alkaloid of ipecacuanha, emetine. It was obtained in small hemispherical warty crystalline masses, which, on purification, gave milk-white crystals. From the analysis of the alkaloid itself and of its chlorhydrate, the formula $C_{15}H_{22}NO_2$ is assigned to it.

Schmidt has investigated the action of hydrogen sulphide on the alkaloids, and has produced compounds of it with strychnine and brucine.

Hess has examined minutely the character of opianine, an alkaloid derived from Egyptian opium, and concludes that it is nothing but pure narcotine.

Mallet has published a theoretical paper on the rational formula of urea, uric acid, and their derivatives.

Hill has communicated from the organic laboratory of Harvard College a paper on the ethers of uric acid.

Ritthausen has further examined a nitrogenous substance found by him in the juice of the vetch (*Vicia sativa*), and, finding it to be new, gives to it the name vicin. It has properties analogous to those of asparagin.

Struve has confirmed the opinion of Lechartier and Bellamy that fruits in the absence of oxygen ferment, evolving carbonic gas and producing alcohol, though there can not be discerned any yeast cells in them by the microscope.

Paper and cardboard made from peat were recently presented at a meeting of the Berlin Polytechnic Society, and a factory for its manufacture is about to be erected in Prussia. The paper resembles in quality that made from wood or straw.

In *Physiological Chemistry*, Schutzenberger has continued his valuable researches on albumin and the albuminates.

Gautier and his pupil Scolosuboff have made an extended examination on arsenic in the tissues, and have shown that it principally localizes itself in the nervous tissues. They also describe an improved method of separating it from organic matters.

Commaille has given a means of separating cholesterin from the fatty matters with which it is generally accompanied, and which are often mistaken for it, by taking advantage of the property which cholesterin has of resisting the action of concentrated alkalies, even when boiling.

MINERALOGY.

By EDWARD S. DANA, Ph.D.,
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PUBLICATIONS, RESEARCHES, ETC.

Several important works on Mineralogy have been published during the year past. First among these stands Rammelsberg's "Handbook of Mineral Chemistry." This is a most valuable contribution to the science, both on account of the high position which the author holds in the department, and also because it is the first complete work in which the chemical composition of minerals has been discussed with sole reference to the principles of the New Chemistry. It thus marks an era in the science, since hitherto the new formulas, if given at all, have generally been made subordinate to those of the *old* system.

The "Physical Crystallography" of Professor Groth is also an important work, since it gives a full and systematic, and yet very intelligible discussion of the optical characters of crystals, and the means employed in their investigation. Other new works are the Crystallographies of Klein and of Sadebeck; the former discussing the methods of calculation, and the latter the *natural history* of crystals, their method of growth, and so on. The new (5th) Appendix by Domeyko to his "Mineralogy" may also be mentioned; the new minerals described in it are enumerated in the list which follows.

Two mineralogical societies have recently been inaugurated in England, one of which is called the "*h k l*," after Professor Miller's classical crystallographic symbols. Moreover, it has been announced that a new journal, to be devoted exclusively to Mineralogy, is soon to be commenced in Germany; the design is to make it decidedly cosmopolitan in its nature.

In the department of Physical Mineralogy important researches have been published by Hankel, Groth, and others. Hankel has continued his investigations of the pyro-electrical properties of minerals, and has shown that these belong, not, as once supposed, to a few hemihedral minerals alone, as tourmaline, but to all species in a more or less decided degree. Moreover, he has shown that these characters are determined, analogously to the optical properties, by the symmetry of the crystalline form; for instance, in a tetragonal or hexagonal crystal the same kind of electricity is developed in all lateral directions, that is, upon all prismatic planes, but the opposite kind at the extremities of the vertical axis. Groth has deter-

mined the coefficient of elasticity of rods of rock-salt by a series of delicate acoustical experiments. These rods were cut in different directions from the crystal of salt, and the main result arrived at is the proof that the elasticity has different values in different directions, but the same value in all directions crystallographically identical.

Baumhauer has continued his researches upon the figures produced upon the surfaces of crystals of lepidolite, tourmaline, and other minerals by means of various modes of etching. The same method of investigation has proved, in his hands, that crystals of mimetite and pyromorphite are hemihedrally developed in the same way as those of apatite, though it is not apparent in their external forms.

The accurate measurements of crystals of analcite by Schrauf have led him to the conclusion that it, like leucite, must be transferred to the list of tetragonal crystals (instead of isometric). It is claimed, however, by Hirschwald that both species are truly isometric, though showing the phenomena of "polysymmetry." Tschermak has also shown that the common mica, muscovite, is monoclinic, not orthorhombic.

The crystals of chondrodite from Brewster, N. Y., have been shown by an American crystallographer to embrace the same three types of forms that characterize the volcanic mineral humite, of Vesuvius; moreover, the optical characters of the second and third types show them to be *monoclinic*, though they do not agree between themselves. Des Cloizeaux has supplemented these observations by a like examination of the Vesuvian mineral (humite), and has thus shown that the three types must be considered three distinct species; which he proposes to call respectively *humite*, *chondrodite*, and *clinohumite*.

A number of new and strange cases of the association in parallel position of crystals of two distinct species have been described; thus, pyroxene on hornblende, humite on chrysolite, etc. The most remarkable case is that of quartz on calcite, an interesting form of which has been figured from "Specimen Mountain," in the Yellowstone National Park.

A related though quite different subject is the inclosure of one crystal by another, as the strange envelopment of orthoclase by tourmaline described by E. H. Williams (*Amer. Journal of Science*, Feb., 1876). The presence of liquid carbon dioxide in minerals has been confirmed by Hartley, and some new facts in regard to it published. His studies have led him to suggest the idea that *diamonds* may have been formed by the action of reducing agents on very highly compressed carbon dioxide. Dr. Isaac Lea has continued his study of the inclusions, both liquid and solid, by some gems, as sapphire, spinel, etc.

The new localities of American minerals, spoken of in the last vol-

ume of the *Record*, have been further developed during the year, and yielded many fine specimens. Of new occurrences of some interest may be mentioned the staurolite crystals of Fannin Co., Georgia; the pyrrhotite of Elizabethtown, Ontario; the quartz and rutile of White Plains, North Carolina, the former very fine in color and transparency; the columbite from Standish, Maine; sphene from Bridgewater Station, Pennsylvania, and so on.

As the tellurium minerals of this country have exerted a good deal of interest of late years, it is worth noting that some tellurium compounds (hessite, altaite) have been discovered by Domeyko in Chili.

NEW MINERAL SPECIES.

The energy of mineralogists during the past year seems to have been especially directed to the discovery of new species, for the number of new names introduced into the vocabulary of the science is very large. It is probable, however, that some of the newly made species may not have a very long existence. The following is the list of species announced as new:

Achrematite.—A molybdo-arsenate of lead, of a yellow color, and indistinct crystalline structure. The locality is Guanaceré, Chihuahua, Mexico. Described by Professor J. W. Mallet.

Aerinite.—Essentially a hydrous silicate of iron and aluminum, characterized by its intense azure-blue color. The structure is massive and earthy. It forms the paste which binds together fragments of quartz, chrysolite, feldspar, and augite, and has probably itself arisen from the decomposition of other silicates. Locality, Spain.

Calcozincite.—A doubtful mineral containing zinc, calcium, water, and carbonic acid. Massive; color, orange-red. Sterling Hill, N. J.

Cuprocalcite.—A basic carbonate of copper and calcium, somewhat allied to malachite, but having an intense vermilion-red color. Occurs in small massive fragments in carbonate of calcium. From the mines of Canza, in Peru.

Clinohumite.—The third type of humite. (See above.)

Daubréelite.—Proto-sulphide of chromium, occurring as a coating of triolite nodules in the meteoric irons of Northern Mexico. Described by Professor J. Lawrence Smith.

Daubreite.—An oxychloride of bismuth, from the Constancia Mine, in Bolivia. Amorphous, structure somewhat fibrous; the color yellow and yellowish gray. Specific gravity 6.5, and hardness 2.5 (Domeyko). Both this and the preceding species named for M. Daubrée, of Paris.

Euchlorite.—A silicate of iron and magnesium. Occurs in coarse scales, with a light olive-green color. Distinctive characters, wanting. Chester, Mass.

Friedelite.—A hydrous manganese silicate, allied to hydrotephroite. Occurs in hexagonal plates and in granular masses; color, rose-red.

Adervielle, Hautes-Pyrenées. Named by M. Bertrand in honor of M. Friedel.

Gastaldite.—A member of the amphibole group of minerals, but in composition essentially a silicate of aluminum. Found in chloritic slate in the valley of Aosta; occurs in prismatic crystals; color, dark-blue. Named by Sr. Strüver in honor of Sr. Gastaldi.

Hermannolite.—A mineral very near if not identical with columbite, from the old locality at Haddam, Conn. Supposed to differ in chemical composition.

Huantajayite.—A chloride of sodium and silver, allied to halite and cerargyrite. Crystallizes in cubes of a white color. From the mine of San Simon, Cerro de Huantajaya, Chili.

Hydrotitanite.—A mineral which has been produced by the alteration of crystals of perofskite; all the lime and some of the iron having been removed, and water been taken up. The crystals have retained their original form, but the color has become grayish white. Locality, Magnet Cove, Arkansas. Described by Dr. Koenig, of Philadelphia.

Ihleite.—A hydrous sulphate of iron; occurs as a yellow efflorescence on the graphite of Mugrau, Bohemia.

Keatingine.—A variety of fowlerite, from Franklin, N. J.

Krönkite.—A double sulphate of copper and sodium, of a brilliant blue color; and occurring in crystalline masses having a prismatic structure. It feels moist to the touch, and upon prolonged exposure to the air it becomes greenish, and partly loses its transparency. From the mines of Calama, in Bolivia.

Leviglianite.—A ferriferous variety of guadalcazarite, from Levigliani, Italy.

Malinowskite.—A variety of tetrahedrite, containing considerable silver and lead. From the mine of Carpa, Peru.

Melanophlogite.—Occurs in minute cubes, having a light brownish color, which are implanted on calcite and celestite from Sicily. The mineral contains silica, sulphuric oxide, and water, though the exact composition is yet doubtful. The hardness is nearly that of quartz. Its most peculiar character, to which it owes its name, is that it turns black on being heated.

Microschörlite and *Microvermiculite* are names given by Herold to microscopic crystals, of uncertain nature, observed in the kaolin of Thuringia.

Mottramite.—A hydrous vanadate of copper and lead, occurring as a black, velvety incrustation on sandstone. At Mottram St. Andrew's, Cheshire, England. Described by Professor Roscoe.

Parankerite.—A name given by Boricky to a special group of the minerals which are embraced under the general term of *ankerite;* that is, carbonates of calcium, magnesium, and iron, in varying proportions. From Bohemia.

Pelhamine.—A variety of serpentine of uncertain character. Pelham, Mass.

Phillipite.—A hydrous sulphate of copper and iron. Occurs in small masses of a deep-blue color in a clay. Province of Santiago, Chili.

Pilinite.—A hydrous silicate of aluminum and calcium; allied to the zeolites. Found in fine, white, flexible needles, having a silky lustre, in the granite of Striegau, Silesia.

Psittacinite.—A hydrous vanadate of lead and copper, nearly allied to mottramite. (See above.) Occurs in thin, crypto-crystalline coatings of a green color. Silver Star District, Montana. Described by Dr. Genth.

Pyroconite.—Identical with pachnolite. Greenland.

Roscoelite.—A vanadate of aluminum and potassium, described by Professor Roscoe, and also by Dr. Genth, with different results. Occurs in scales grouped in stellate or fan-shaped groups; the color greenish gray. Found in small seams in a gold-mine at Granite Creek, El Dorado County, California. Named by the discoverer, Dr. James Blake, for Professor Roscoe.

Schraufite.—A new fossil resin, of a hyacinth-red color; from Bukowina.

Siderazot.—Nitride of iron; found at the volcano of Etna.

Vanuxemite.—Supposed to be a hydrous silicate of aluminum and zinc. From Sterling Hill, N. J.

Werthemanite.—A subsulphate of aluminum, differing from aluminite in containing less water. Found near the city of Chachapoyas, Peru.

GEOLOGY.

By T. STERRY HUNT, LL.D., F.R.S.,
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The Geological explorations which, under the authority of the United States government, have been going on for the last few years in the western part of our territory, have reached a point where it becomes possible to generalize the observations.

GEOLOGY OF THE FORTIETH PARALLEL.

Clarence King has given us, in anticipation of his published volume, an important contribution to the history of the Paleozoic series as displayed along a belt of about one hundred miles in breadth, following the 40th and 41st parallels of latitude from the 104th to the 120th meridian, or from the eastern base of the Rocky Mountains to the confines of California. By a careful study of the outcrops and of their organic remains, he and his assistants have been able to make out the succession, and to correlate the various divisions with the New York series of rocks. The Paleozoic strata of the eastern half of the continent, generally estimated at 40,000 feet in Pennsylvania, are diminished to about one tenth of that thickness on the Mississippi; and in the eastern part of the Rocky Mountains have a total thickness of not more than from 900 to 1200 feet, including at the base Cambrian, and at the summit Carboniferous strata; the whole forming apparently one conformable sequence, which rests in discordance upon crystalline rocks of Eozoic age. This Paleozoic series rapidly thickens westward to a volume of not less than 32,000 feet in Utah; and many divisions not recognized in the eastern part of the region under consideration are developed with great force and persistence in Utah and Nevada. Near Battle Mountain, however (longitude 117° 25'), the Paleozoic series is interrupted by a barrier of Eozoic rocks. The Rocky Mountain region was in Paleozoic time a shallow sea, with islands of Eozoic rock, while, beyond, the ocean deepened over a great basin to the western shore.

THE WAHSATCH SECTION.

In the Wahsatch range a single section is seen 30,000 feet in thickness, including Lower Cambrian, and extending through Silurian, Devonian, Carboniferous, and Permian, which latter is overlaid by Trias; the whole succession being without any observable stratigraphical break. The base of this great conformable series consists

of quartzites, conglomerates, and slates; attaining in the Wahsatch 12,000 feet in thickness, and, so far as known, destitute of fossils, with the exception of about seventy-five feet of impure limestones and shales at the top, which contain a fauna designated as Potsdam. In Middle Nevada, however, this thin fossiliferous layer is expanded to at least 3000 feet of dark-colored limestones, carrying throughout a Lower Cambrian fauna; while in the Rocky Mountains, to the extreme east, these strata thin out, and never exceed 100 feet.

THE UTE LIMESTONE.

Immediately overlying these Cambrian shales is what is named the Ute limestone which, from 1000 feet to the southward, attains 2000 feet in the Wahsatch; while in Western Nevada, where the calcareous strata of the Potsdam are greatly thickened, we have 4000 or 5000 feet of limestone. In the Wahsatch the middle part alone of this limestone has yielded fossils, which are of Quebec (that is, of Levis or Tremadoc) age, while the great calcareous mass farther west has more than one half its volume of so-called Primordial or Potsdam age, and a portion of Levis; a large part contains forms of Niagara, followed by Lower Helderberg, the precise limits of these not being yet defined.

THE WAHSATCH LIMESTONE.

Succeeding this is the Wahsatch limestone, having a thickness of 7000 to 8000 feet, and containing faunas of Devonian (Upper Helderberg and Chemung) age. This is separated from the Ute limestone by the Ogden quartzite, a green or white sandstone—sometimes schistose and at other times conglomerate—which in different localities varies from 1600 to 700 feet in thickness, and in some parts is wanting, or represented only by silicious impurities in the limestone. It is regarded as the representative of the Schoharie and Cauda-galli grits of New York. The base of the Wahsatch limestone presents in some localities an intermingling of Lower with Upper Helderberg forms—making as yet somewhat uncertain the horizon between Silurian and Devonian. Black slates, which in one locality overlie the Chemung limestone, are supposed to be equivalent to the Genesee group, above which are beds holding a Waverley or Upper Devonian fauna. Still higher in the Wahsatch limestones occur Lower Carboniferous, followed by true Coal-measure forms. This vast body of limestone above the Ogden quartzite thus contains from 1000 to 1400 feet of Devonian, from 1000 to 1200 of sub-Carboniferous and Waverley, and from 4000 to 4500 of true Carboniferous.

THE WEBER QUARTZITE.

To this succeeds the Weber quartzite, which in the Wahsatch has a thickness of 6000 feet, increasing to 9000 or 10,000 feet in the Oquirrh, and probably to even a greater volume in Western Nevada.

With the exception of some red sandstones at the base, it is chiefly a quartzite; though in parts becoming a coarse sandstone, occasionally conglomerate. Though as yet without discovered fossils, it is shown to belong to the Carboniferous from the fact that it is conformably overlaid by 2000 or 2500 feet of shales, sandstones, and chert-beds, with arenaceous limestones, holding throughout Coal-measure forms, and represented in some parts of the distribution by a continuous body of limestone. In the marine limestones of the Wahsatch division there are found, in Middle Nevada, some plant-bearing earthy coal-beds. We have thus a series of at least 16,000 feet of sediments belonging to the true Coal-measures; following which are a few hundred feet of argillaceous, sandy, and calcareous rocks, the fauna of which appears to offer a transition to the Permian. The Permian strata themselves are wanting to the west of the Wahsatch. It is, according to King, a question whether the Eozoic barrier which, in Western Nevada, was the limit to the Paleozoic basin, was continental in its character; if so, it would appear, from the Carboniferous strata in the Blue Mountains of Oregon and the Bass range in California, that it included deep westward bays in which Paleozoic sediments were deposited.

THE BLACK HILLS.

The late observations of Jenney have given us further illustrations of the geological succession in the Black Hills of Dakota. The Eozoic strata of this region, which doubtless once formed an island in the Paleozoic sea, are described as consisting of gneisses, and micaceous, hornblendic, and chloritic schists, with interbedded and intrusive granites, overlaid in apparent unconformity by a series of argillites and quartzites. Both of these series are much disturbed and folded, and include auriferous quartz veins. Resting unconformably upon these are 250 feet of sandstones, which at the base are conglomerate, including fragments of the older rocks and of their auriferous veins; and higher up soft sandstones and shales, with fucoids. Above this are 300 or 400 feet of massive Carboniferous limestone, separated from the underlying fucoidal beds by a few feet of calcareous sandstone, holding the same fauna as the limestone. To this succeeds over 400 feet of red sandstones, limestones, and marls, with gypsum, regarded as Triassic, overlaid by Jurassic strata with an abundant fauna, and not exceeding 500 feet in thickness; to which succeed the Cretaceous and Tertiary strata of the region. The whole section, up to the summit of the Cretaceous, presents no evidence of want of conformity, and offers not more than 700 feet as the representative of the Paleozoic period. The strata below the Carboniferous are by him regarded as Cambrian, and called Potsdam.

THE UINTA MOUNTAINS.

The lately published researches of Powell on the Colorado give us the details of the geological succession in the Uinta Mountains. The sedimentary groups of what he has called the Plateau Province rest upon a series of Eozoic rocks, to which he has given the name of the Red Creek quartzite, consisting of quartzites, interstratified with hornblendic, chloritic, and micaceous schists, in appressed folds. The thickness of these crystalline schists is provisionally put down at 10,000 feet. Resting unconformably upon these rocks, and holding at its base fragments derived from them, is the Uinta group of sandstones, quartzites, and shales, measuring 12,500 feet in thickness, and provisionally regarded by Powell as Devonian. This had suffered great erosion previous to the deposition of the Carboniferous series, and is divided in ascending order into about 400 feet of sandstones, known as the Lodore division, followed by a mass of 2000 feet, chiefly of limestone; above which are the Lower and Upper Aubrey groups, each 1000 feet in thickness, and both consisting of limestones, with some interstratified sandstones and cherty layers, making thus a total of 4400 feet of rocks of Carboniferous age, resting sometimes on the crystalline schists, and sometimes on the eroded Uinta sandstone. In the Grand Cañon of the Colorado, however, the Carboniferous rests in part upon crystalline rocks, which Powell regards, like the Red Creek group, as Eozoic (and which consist of hornblendic and micaceous schists, with beds and dikes of granite), and in part upon what he calls the Grand Cañon group of sediments. These consist of about 10,000 feet of sandstones, shales, and limestones, with imperfectly preserved fossils, probably Cambrian, down to the base. Between this group and the Carboniferous are about 800 feet of sandstones, shales, and limestones, designated as the Tonto group. These are found to rest upon the eroded basset edges of the lower sandstones; and being followed conformably by the Carboniferous, were by Powell assigned to the latter period, though, from the presence in it of Cruziana, it has been referred to a lower horizon. In some parts the Tonto group rests directly upon the crystalline schists.

PALEOZOIC FOSSILS.

The series above the Tonto group, according to White, includes the Lower Carboniferous, Carboniferous, and Permian; while the Grand Cañon strata have yielded as yet but few fossils, among which have been identified only Lingulella and Obolella. In parts of Utah, Nevada, and Arizona he has found trilobites of the genera Olenellus, Conocoryphe, and Agnostus, showing a low Cambrian horizon. The characteristic crustacea of the Levis limestone are met with in several localities, and in one place the Phyllograptus of the so-called

Quebec group. Trenton forms have been found in New Mexico and parts of Arizona and Nevada, associated in the latter region with the characteristic graptolites of the Utica. It would thus appear that the faunas characteristic of all the principal paleozoic divisions of the East are already recognized in different parts of this great Western basin. Large deposits of gypsum, with strong brines, are found in Colorado near the base of the Carboniferous series—a fact which recalls similar deposits at the same horizon in various parts of Eastern North America.

MESOZOIC OF THE WEST.

Powell has, moreover, given us a section of the Mesozoic and Cenozoic rocks. Instead of the conformable succession observed by King, as well as by Hayden, Comstock, Bradley, and more recently by Jenney, for the whole series of Paleozoic and Mesozoic rocks, it has been seen that in the Colorado section we have a stratigraphical break at the base of the Tonto group. Another occurs at the summit of the Carboniferous, upon the eroded edges of which is a conglomerate forming the base of the Mesozoic. The lower Mesozoic here consists of 5200 feet of sandstones and limestones, often cherty, with gypsum at many horizons; the whole series, divided by Powell into four parts, is regarded as the equivalent of the Jurassic, perhaps including at its base a representative of the Triassic.

COAL-BEARING SERIES.

Overlying conformably these gypseiferous and calcareous sandstones are the Cretaceous and Tertiary coal-bearing strata, consisting chiefly of sandstones, carbonaceous shales, and beds of coal or lignite. Of these he refers 6100 feet, including, in ascending order, the Henry's Fork, Sulphur Creek, Salt Wells, and Point of Rocks divisions, to the Cretaceous. Upon the plicated and eroded surface of the latter rests the Bitter Creek group of 3000 feet of sandstones, with some limestone, much gypsum, carbonaceous shales, and numerous lignite beds, followed by 800 feet of the similar strata of the Lower Green River division, upon the eroded surface of which rests a mass of sandstone overlaid by the calcareous beds and lignites of the Upper Green River division, 300 feet in all. This forms the summit of the great lignitic coal-bearing series, of which, as we have seen, 6100 feet are by Powell referred to the Cretaceous, and 4100 to the Tertiary, making a total thickness of 10,200 feet.

Conformably above this comes the Bridger group of 8000 feet of sandstones, chiefly glauconitic, with limestones, marls, and flints, separated by a stratigraphical break from 1800 feet of somewhat similar rocks, called the Brown's Park group; while over the disturbed and eroded surface of this spreads, the highest of all, the Bishop's Mountain conglomerate of 300 feet, making a thickness of Mesozoic

and Cenozoic rocks of not less than 19,500 feet, marked by four stratigraphical breaks. If to this we add 16,960 feet for the Carboniferous and Uinta groups, and 10,000 for the sandstones of the Grand Cañon, we shall have a total thickness of 49,460 feet from the base of the Paleozoic series to the summit of the Tertiary in this region.

WESTERN EOZOIC ROCKS.

The study of the geology of this great western half of the American Paleozoic basin shows, as Gilbert remarks, that its rocks were deposited upon a subsiding Paleozoic continent, over which we can trace the advancing shore-line of the Paleozoic sea, which at length covered all but some isolated and more elevated areas. The same state of things obtained to the eastward also, where there is no warrant whatever for the familiar notion, based on a singular misconception, of a continent growing around a Laurentian nucleus. The Paleozoic strata in this western region are every where clearly distinguished by their uncrystalline character from the crystalline Eozoic rocks. In one case only, in New Mexico, quartzose schists, holding hornblende and andalusite, are said to occur interstratified with uncrystalline strata carrying Paleozoic fossils. The fact, however, that these strata are in parts vertical, and are traversed by faults, and brought in contact with gneiss and crystalline schists of admitted Eozoic age, suggests caution in fixing the horizon of these supposed Paleozoic crystalline schists. Different observers have referred portions of these crystalline rocks to the Laurentian and the Montalban series; but careful studies are yet wanting to establish their true relations.

METALLIFEROUS DEPOSITS.

A great part of the deposits of the precious metals in this western region are in veins in the Eozoic rocks, but it is well known that they occur also in the Cambrian and the Carboniferous rocks; while silver ores are found impregnating rocks of Cretaceous age, showing that the transportation of the precious metals has been going on up to a comparatively late period.

ERUPTIVE ROCKS.

Eruptive rocks, as is well known, are found penetrating and overlying the strata even of later tertiary age in the West. According to Richthofen, there was a natural and constant order in their extravasation, the acidic rocks—trachytes and rhyolites—being always older, and the basic rocks—basalts and dolerites—newer, penetrating and overlying the former. This would seem to be an instance of hasty and imperfect generalization. The writer has long since shown that some of the eruptive dolerites of Canada are of pre-Paleozoic age; and the observations of Le Conte and of James

Blake in the West (*Record*, 1874, lxxi.) have made known the existence of repeated intercalations, by successive outflows, of trachytic and doleritic rocks. Marvine has since pointed out another instance of the kind in Nevada, where two or more beds of dark-colored olivenitic basalt, with interposed sandstones, are capped by a great mass of pinkish trachyte or rhyolite holding sanidine and quartz, and including pebbles of the underlying basalt.

CRYSTALLINE ROCKS OF MICHIGAN.

The crystalline schists of the northern peninsula of Michigan have been again discussed by Brooks, who, after the Canada Survey, has referred them to the Huronian period. He calls further attention to the existence at the summit of the series of a group of granitic rocks, with hornblendic and micaceous schists holding staurolite and garnet, the whole being, according to him, apparently younger and different in character from any of the known Huronian rocks. The writer had already described these rocks in 1871, and then referred them to the White Mountain or Montalban series, of which they have both the lithological characters and the geognostical relations.

THE KEWEENIAN SERIES.

The series of sandstones and trappean rocks which carry the native copper of Lake Superior has been by Irving studied in Wisconsin, where is found a westward extension of the Lake Superior synclinal of these rocks, and where they have an apparent thickness of more than 20,000 feet. They are there as clearly distinct from the underlying Huronian series as from the overlying horizontal sandstones of Lake Superior, which are, according to Irving, traced westward beneath the Lower Paleozoic sandstones of the Mississippi Valley, of which they are apparently inferior members. Brooks now concludes that the granitoid and micaceous formation just noticed, which he places at the summit of the Huronian, is unconformably overlaid by the copper-bearing formation, which he proposes to recognize as a distinct series under the name of Keweenawian. The writer had, however, already in 1873 named it the Keweenaw series; and if an adjective is desired, Keweenian will be more euphonious than the word proposed by Brooks. The evidence, then, is to the effect that the succession in this region is: 1. Laurentian; 2. Huronian; 3. Montalban; 4. Keweenian; 5. Lower Cambrian—to which period the overlying sandstones must be referred. This disposes of Bradley's late strange suggestion that the Huronian is probably altered Lower Silurian—that is to say, Lower Cambrian.

CRYSTALLINE ROCKS OF PENNSYLVANIA.

Hunt has described the crystalline rocks of the South Mountain between the Delaware and the Schuylkill, and of the Welsh Mount-

ain between the latter river and the Susquehanna, as clearly of Laurentian age, and has referred to the Montalban, the Philadelphia gneiss and mica-slate series. He points out the existence of a hitherto unnoticed Laurentian belt farther to the southeast, which separates the Auroral limestones on that side of the Mesozoic from the Montalban series; and he notices between the latter and the Laurentian a belt of Huronian strata of varying breadth, which is probably unconformable with the Laurentian. He moreover describes the South Mountain range, where it reappears again to the south of the Susquehanna, as consisting, in Pennsylvania, chiefly of a large development of Huronian strata, including great interstratified masses of orthofelsite or petrosilex rocks (the hälleflinta of the Swedish geologists), which frequently pass into a quartziferous feldspar-porphyry, generally of some reddish color. These acidic rocks represent in the Huronian the gneisses of the Laurentian and the Montalban, and here, as elsewhere, are found to be distinctly stratified, and intercalated with greenstones and chloritic and epidotic rocks. He regards them as the equivalents of similar rocks which form a part of the Huronian series along the eastern coast of New England and New Brunswick, and of the iron-bearing orthofelsite porphyries of Missouri. They are also developed along the northern shore of Lake Superior, and their ruins enter largely into the conglomerates of the Keweenian series in Northern Michigan.

LOWER TACONIC ROCKS.

Hunt has further described the characters of the Primal and Auroral rocks of Rogers, as seen in the region to the southeast of the North Mountain in Pennsylvania. These rocks were assumed by Rogers to be the stratigraphical equivalents of the Potsdam, Calciferous and Chazy of the New York series, and of the undoubted representatives of these which occur west of the North Mountain. They are the Lower Taconic quartzites and limestones of Emmons, maintained by him to occupy a lower horizon than the base of the New York fossiliferous series. They constitute, according to Hunt, a partially crystalline series, distinct from and newer than the Huronian and Montalban. Interposed in the detrital rocks of the Primal are schistose beds charged with micaceous and chloritic matters, crystalline limestones often inclosing serpentine, and important beds of magnetite, as at Boyertown, Cornwall, and Dillsburg, all of which present mineralogical characters unlike those of the underlying crystallines. Similar conditions extend into the Auroral magnesian limestone, giving to these two formations a distinctive character. They were evidently deposited over a subsiding continent with bold shores, so that while the Primal has in some places a very great thickness, it is elsewhere very thin or entirely wanting beneath the Auroral, which rests directly upon the older crystalline rocks.

INVERSIONS OF STRATA.

Hunt further points out that we have in this region many illustrations of what seems to be a common fact, that when newer strata deposited around the base of a ridge or barrier of older rocks have been subjected to folding, they often assume a dip toward the barrier. The movement in such cases, apparently due to lateral pressure, has sometimes even involved the older rock itself, and caused it to be folded over, so that the newer strata are actually inverted and overlaid by the older and unconformable rocks, as may be seen in the South Mountain in New Jersey.

ORIGIN OF LIMONITES.

The presence in these Primal and Auroral strata of great beds and masses of pyrites, and of others of carbonate of iron, is also noted; and where, as is often the case, these rocks are deeply altered by meteoric agencies, the sulphuret and carbonate have been changed into hydrated oxide of iron, which, in the form of limonite, abounds in the clays resulting from this process of decomposition.

DECAY OF ROCKS.

This decay of the strata, so noticeable in these Lower Taconic rocks, is also seen in the Laurentian gneisses of the South Mountain, where these are protected from erosion. In such cases the partially decomposed feldspathic rocks often contain nuclear masses of the unchanged rock — boulders of decomposition. Belt has pointed out in Nicaragua examples of the slipping or sliding of such decayed rocks on a mountain-side, by which undecayed portions are carried down the slope and involved in the displaced material. Kerr has lately further illustrated the question in North Carolina by showing that alternate freezing and thawing of such decayed rocks on a declivity may cause the descent of the material, with scratching of the surface, thus giving rise locally to phenomena similar to those often ascribed to sub-aerial glaciers. Such movements of decayed crystalline rocks, either with or without the aid of congelation, have no doubt in some regions been mistaken for the result of ice-action.

LAURENTIAN AND NORIAN OF THE ADIRONDACKS.

Professor James Hall has studied the arrangement and distribution of the crystalline rocks in parts of the Adirondack region, and has verified the old observations of the Canadian Survey that the labradorite and hypersthene rocks, with titanic iron ores—the Norian series—rest unconformably upon the Laurentian gneisses, which contain the pure magnetic ores of the region.

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CRYSTALLINE LIMESTONES.

Hall finds that certain serpentinic limestones of the region are newer than both of these series, which they overlie unconformably, including at the same time fragments derived from the gneisses. That crystalline limestones containing serpentine and various other minerals do, however, form portions of the Laurentian series in Canada is undoubted, but it by no means follows that all such crystalline limestones belong to this horizon. Hunt has pointed out that limestones, much resembling in mineralogical characters those of the Laurentian, occur in the Montalban of New England, and also, as noticed above, that serpentinic limestones are found in the Lower Taconic rocks of Pennsylvania. These facts give an additional interest to the important observations of Hall. Some late researches of Vennor in the province of Ontario tend to similar conclusions.

THE QUEBEC GROUP OR UPPER TACONIC.

The fauna of the Lower Taconic rocks in Pennsylvania is scarcely known, but in addition to a Scolithus, which differs from that of the New York Potsdam, Prime has made known the existence of an undetermined linguloid shell, and also of impressions similar to the Monocraterion found by Torell in the lowest Cambrian beds of Sweden. Referring to the lower divisions of Paleozoic time, Hunt has again called attention to the fact that the so-called Quebec group of Logan (the Upper Taconic of Emmons) was based upon an inverted succession of strata on an overturned anticlinal. The slates with compound graptolites, of the Levis division, which were represented by Logan as inferior to the Levis limestones, are of the age of the Skiddaw or Arenig rocks, while the limestones themselves are the equivalents of the Tremadoc division of Great Britain. The Sillery, which was regarded as the summit of the Quebec group, is much lower, and probably of Menevian age. In the province of Quebec it rests in some localities on the crystalline schists of Huronian age, which were supposed by Logan to be the Levis and the overlying Lauzon division in an altered condition, although the Levis rocks are now shown by their fauna to belong to the upper part of the series, and contain fragments of these same crystalline schists.

CRYSTALLINE ROCKS OF SCANDINAVIA.

Pettersen has described the crystalline rocks of Northern Norway as including an older series of red and gray gneisses, often hornblendic, with micaceous and hornblendic schists and much crystalline limestone. These are overlaid by a series of argillaceous and hornblendic rocks, with gabbro (diorite or diabase) olivine-rock, serpentine and steatite, and associated copper and nickel ores. Related strata are described by him as a series of many-colored argillites,

with greenstones, ferriferous dolomites, red hematites, and copper ores. These groups of metalliferous strata are much contorted, without organic remains, and are conjectured by Pettersen to be either of Silurian or Devonian age, though they have the characteristics of Huronian rocks. In other parts of Scandinavia the notion of altered Paleozoic rocks is carried to a much greater extent, and, according to Tornebŏhm, all the various types of crystalline Eozoic rocks, including the granitoid gneisses, are reproduced again at a higher horizon, the fossiliferous Paleozoic rocks which repose on the Eozoic being supposed to pass beneath, and to be more ancient than this second and newer set of crystalline strata. It remains to be seen whether this is really the case, or whether this apparent superposition results from the same structure as has been described above in the Appalachians.

MARBLES OF CARRARA.

A similar question continues to occupy the geologists of Southern Europe, where the crystalline rocks of the Alps, Apennines, and Pyrenees have been by different observers assigned to very different horizons. The statuary marbles of Carrara are an example of this. A generation since they were looked upon as eruptive; then, together with their associated crystalline schists, they were declared to be altered Cretaceous. They were subsequently referred to the Lias, until shown to be unconformably overlaid by Liassic strata and to rest in discordant stratification on crystalline schists, when they were assumed to be altered strata of Rhætic age. Later observations placed them beneath the coal-measures, and the Carrara marbles were then called Lower Carboniferous, to which horizon some have also referred all the statuary marbles and micaceous limestones of Central Italy. Similar statuary marbles in the Pyrenees, formerly regarded as altered Mesozoic, are now considered to be Carboniferous, or still older. According to Gastaldi the marbles and micaceous limestones of Italy just referred to are still more ancient, and are closely related to the *Pietre verdi* group; so that their position, if not pre-Paleozoic, is at the very base of the Paleozoic series.

CRYSTALLINE ROCKS OF ITALY.

The name of the *Pietre verdi* or greenstone group, is given in Italy to a widely spread series of stratified rocks of great thickness. It consists, to a large extent, of rocks with triclinic feldspars—the so-called gabbros and diabases—together with great masses of serpentine, and diallage, and steatitic, chloritic, and epidotic strata, the whole associated with quartzose and calcareous schists. These rocks have been by most geologists looked upon either as eruptive or as contact-deposits resulting from the action of eruptive masses upon uncrystalline strata, and have been assigned, from their supposed

stratigraphical relations, to very different geological ages. According to Lory they are Triassic, while within the past year some have been found closely associated with Silurian or Devonian fossiliferous strata. De Stefani assigns certain of them to a horizon between the Carboniferous and the Lias, others of them he refers to the Cretaceous, and others still are stated by him to overlie the middle and lower Eocene. Gastaldi has, however, recently reviewed the whole subject, and concludes that the rocks of the *Pietre verdi* are not eruptive but indigenous, and constitute a well-defined series of beds and lenticular masses, of great thickness, in which the serpentines occupy a position near the base. The *Pietre verdi* has, according to him, a constant and well-defined horizon, which is pre-Paleozoic, and its rocks never make their appearance in other formations. This formation, which has all the characters of the Huronian, to which he has provisionally referred it, rests unconformably upon a great series of gneissic rocks, often porphyroid and granitoid, which include deposits of graphite, beds of quartzite, lenticular masses of white statuary marble, and doubtless represent the Laurentian. Overlying the *Pietre verdi* is another great series of quartzites, and schistose limestones and dolomites, including beds of gypsum near the summit. These groups of ancient crystalline strata, according to Gastaldi, constitute the basal rocks of the Alps and Apennines, and may be followed from Mont Blanc to the Danube, the Adriatic, the Mediterranean, and to the plains of France, overlaid in part by newer strata. These views are in accordance with those maintained by Favre and many others, who have shown by repeated instances that the apparent interstratification of older among newer rocks in these regions is due to inversions and dislocation. The writer, some years ago, from his studies of Alpine geology, was led to maintain the view defended by Gastaldi, and asserted the Eozoic age of these crystalline rocks, including the *Pietre verdi*.

CAMBRIAN ROCKS OF EUROPE.

Hicks has discussed the different conditions presented by the Cambrian and Siluro-Cambrian rocks in Wales, where they have a united thickness of 30,000 feet, and in Scandinavia and Russia, where they are 1000 feet or less. He supposes them to have been deposited over a slowly subsiding continent of Eozoic rocks, the surface of which sloped toward a deep ocean to the southwest, and in accordance with this view concludes that the earlier members of the Cambrian below the Menevian horizon are wanting in Scandinavia, which was not submerged till then. To this Linnarsson objects, maintaining that both the Menevian and the fossiliferous Harlech strata, which underlie it in Wales, are represented by the Paradoxides beds of Scandinavia, where below these are still recognized two distinct horizons of Paleozoic sediments, the Fucoidal sandstone and

the underlying Eophyton sandstone. Neither of these contain any trilobites, but they afford brachiopods, pteropods, sponges, etc., besides the moulds of what are regarded by Torell as two radiate animals, designated by him as Monocraterion and Diplocraterion. The thickness of these two sandstones in Middle Sweden is but 100 feet, but in Northern Norway they equal 2000 feet, and include schists and limestones. Above the Paradoxides beds in Sweden are the Olenus beds, which, although but forty feet in thickness, are supposed to represent the 4000 feet of Lingula flags found in Wales between the Menevian and the Tremadoc. Linnarsson concludes that the Paleozoic sediments known in Scandinavia are at least as old as any thing discovered in Wales, where, however, there are 1500 feet of sediments known beneath the Harlech trilobites. The fossiliferous schists of the Baltic provinces of Russia, which are referred to a horizon above the Lingula flags, have conformably beneath them several hundred feet of shales and friable sandstone, the so-called Ungulite grits, of the fauna of which very little is known, and which rest directly on the crystalline rocks. The primordial zone of Barrande, in Bohemia, is regarded by Linnarsson as equivalent to the middle portion of the Paradoxides beds of Sweden; although no species of crustaceans are common to the two, there are many analogous forms. Linnarsson on paleontological grounds rejects, as we have seen, the view that the basal fossiliferous rocks of Scandinavia are less ancient than those of Wales; but the constantly recurring question comes up whether such a similarity or identity of organic forms in widely separated regions indicates synchronous deposition, or whether the successive appearance and disappearance of these in Scandinavia may not have occurred at a somewhat later period than in Wales.

CARBONIFEROUS ROCKS IN GERMANY.

The great region of sedimentary rocks in Moravia and Silesia, long known for its roofing-slates, remained without any evidence of its geological age until 1860, when fossils of Carboniferous age were found, which showed its equivalence to the Culm formation of Nassau. Since then the structure of this great mass has been unraveled, and it has been shown to consist of three divisions, each of which carries an abundant fauna of Carboniferous age, now first described by Steer, and a marine Paleozoic fauna. These three divisions, which are of nearly equal thickness, each consist of sandstones and conglomerates, with roofing-slates, and have a united thickness of 70,000 or 80,000 feet.

ARCTIC GEOLOGY.

Nordenskjöld, from the results of his long researches in arctic geology, attempts to discuss the question of the arctic climate in

former geological periods. We have there no clear evidence with regard to the Silurian and Devonian ages; but in the Carboniferous time there was an extensive continental area around the pole, supporting a colossal vegetation, the remains of which, inclosed in sandstones, rest in Spitzbergen upon a great formation of marine limestone rich in corals of Carboniferous age. The Trias of this region shows gigantic cephalopods and great saurians, which also point to a tropical climate, and the succeeding Jurassic in Spitzbergen is terrestrial, with large cycads and conifers. The Cretaceous of the polar regions also, according to this same observer, shows two horizons—a lower one, with a flora which Heer compares to that of Egypt, and an upper, which contains a great variety of deciduous trees, and indicates, for the first time, a slight change of climate. The Eocene is wanting in these regions; but we have the wonderful Miocene flora, which was spread over a great arctic continental area, and is well known to have resembled that of Central Europe, or of the Ohio valley of to-day.

FORMER ARCTIC CLIMATE.

Nordenskjöld, moreover, fails to find evidences of former glacial agencies in the sandstones of these regions from which we might infer the former existence of alternations of warm and cold climates. The advent of frost followed the Miocene period. Recent speculations have revived the old notion of a possible change of the earth's axis of rotation as a way of explaining this change of arctic climate; but such a phenomenon is astronomically improbable, and is also opposed by the fact that the direction of oceanic currents, which are guided by the earth's rotation, appears, from the distribution of marine sediments, to have been the same since very early periods. Something may have been due to the depression of parts of the present continents, which may have permitted the influx of warm waters into arctic seas, but the evidence shows the existence of arctic continental areas charged with vegetation. A simple solution of the problem seems to be that long since proposed by the present writer, that the presence of a larger amount of carbonic acid in the atmosphere up to a late period, maintained, in accordance with well-ascertained physical laws, a tropical temperature over the whole earth's surface, at the sea-level.

ANTARCTIC CLIMATE.

In this connection may be noted the question of a glacial period in the southern hemisphere. McCoy, from his studies of the fossil forms of Southern Australia, concludes that there is no evidence of a former period of greater cold, but that there has been a gradual diminution of temperature down to the present time. Hutton shows that the evidence in New Zealand is to the same effect, as Hector had already done before him.

THEORIES OF GLACIATION.

The bearing of these observations and conclusions on theories of glaciation is important. While some are content to limit the action of ice to superficial modifications of the surface, others, as is well known, maintain that the grandest valleys and the deepest and broadest lakes have been sculptured by its agency, and that no former distribution of land and water is sufficient to explain the extent of the ancient glaciers; which were ice-caps stretching from the poles to the equator, to explain the existence of which it is necessary to resort to astronomical causes. These causes, according to different theorists, would involve both hemispheres either simultaneously or alternately, giving a succession of glacial periods which, it is claimed, can be traced far backward in geologic time. Such views, it is evident, are not easily conciliated with the late observations in the arctic regions, in New Zealand, and in Australia; and some of our best physicists and astronomers venture to question the soundness of the astronomical hypotheses of this school of glacialists. The marks of a universal ice-sheet should be found all around the globe in the same latitude and at the same levels, while it is well known that glacial phenomena are limited to certain meridians, and that great breadths afford no indications of ice-action. Hence the view of local glaciers of great extent, the origin of which it is possible to explain by geographical causes alone, now finds favor with many, while increasing attention is given to the action of ice-floes and shore-ice.

There are many problems relating to erosion and the transport of materials which it is attempted to explain by glacial agency, and the question how far this has been operative is now being discussed by many observers, especially in Great Britain. In opposition to the views of Goodchild, who supposes them due to the eroding action of a great ice-sheet, Miller endeavors to show that certain escarpments in Yorkshire must have been pre-glacial, and Mackintosh maintains that many of the phenomena referred to ice must have been caused by marine action. Tylor in the mean time urges, with great ingenuity, that the present surface-outlines were determined by the action of water rather than of ice, and would substitute for the Glacial a Pluvial period, in which rains, springs, rivers, tides, and currents were far more active than at present — an exaggeration which may be set against those of the other school.

GLACIERS AS ERODING AGENTS.

An important question which, it would seem, should take precedence of all others in the discussion as to the origin and distribution of glaciers or ice-sheets as geological agents, is whether glaciers can act as eroding agents. Bonney furnishes his contribution to the

subject by showing, as the result of long studies of Alpine glaciers, that the plasticity of ice is such that it flows like a river over and around obstacles instead of sweeping them away. An Alpine glacier advancing over a tolerably level surface overrides the loose material in front, scarcely disturbing it, and the great retreating glaciers leave behind them nothing like the boulder-clay or ground moraine; the detrital matter from them, which is small in amount, being, like that of the terminal moraines, derived from the surface of the glacier. He argues that the glaciers, though they have moulded surfaces, have not excavated nor modified the features of the valleys, which are anterior to the glaciers, and are due to fluviatile agencies. There are phenomena of surface-geology for which the hypothesis of great glaciers offers a plausible solution; but it must be received with many limitations, while the objections which are urged against it are such that the present attitude of many judicial minds is at least one of doubt.

GEOGRAPHY.

By Lieutenant-Commander F. M. Green, U. S. N.

Although the progress of geographical knowledge during the year 1876 has not been marked by any very striking discovery, a large number of valuable details have been accumulated in comparatively unknown localities. As maps become more complete and communication with distant countries is improved, the necessity for exact information becomes more and more urgent. The result is to give to geographical investigations a more exact and scientific method. This tendency is very evident in the expeditions of various nations recently fitted out.

THE UNITED STATES.

As in former years, the results of the government exploring and surveying expeditions in United States territory are eminently interesting and satisfactory.

The work of the English and American Commission for marking the boundary-line along the 49th parallel of latitude from the Lake of the Woods to the Rocky Mountains, generally known as the Northern Boundary Commission, has been brought to a close, and the reports to the respective governments, with maps of the country adjacent to the boundary on both sides, will be very shortly published.

The astronomers and topographers attached to the U. S. Commission were officers of the U. S. Engineer corps, and their labors have greatly added to our knowledge of the barren and dreary country through which the boundary passes. Between the Lake of the Woods and the Rocky Mountains forty-one astronomical stations were established, and the boundary was marked by permanent monuments.

Reconnaissances were made north and south of the line, so as to thoroughly explore the country, to a distance of twenty miles to the northward and one hundred miles to the southward of the boundary. All trails which were passed over outside of the belt of accurate survey were approximately surveyed.

The longitude of Pembina, on the Red River of the North, was determined by the telegraphic method of exchanges with Chicago, and a meridian line was traced with great care from a point on the line six hundred and sixty miles west of Pembina to the vicinity of Fort Shaw, where it was intended to observe the longitude by telegraphic

exchanges with Salt Lake; but this plan was frustrated by the bad condition of the telegraph line in Montana, which in 1875 was broken in many places.

The trails thus reconnoitred were from the crossing of the Mouse River *via* Fort Totten to Fort Seward on the Northern Pacific Railroad; from the Missouri at Fort Buford to the boundary, along the two branches of the Poplar River, the meridian trail to Fort Shaw, the Riplinger road along the base of the mountains from the boundary to Fort Shaw, the trail from Fort Buford to Fort Benton, and from Fort Benton to the Sweet Grass Hills. In addition, a reconnaissance of the Missouri River was made while descending that stream in boats, after completing the field-work for the season, in September, 1874.

This reconnaissance demonstrated that the generally received estimate of the distance from Fort Benton to Bismarck is too great by about 400 miles, the survey fixing it at 805 miles.

The country for forty-five miles west of the Lake of the Woods was found to be an immense tamarack swamp only passable when frozen, and necessitating that part of the survey to be made in winter. This was done with some difficulty, the temperature falling as low as 51° below zero. From this swamp to the treeless valley of the Red River the country is woody and somewhat broken. Of the country to the westward of the Red River very little was previously known. From this stream prairie land extends westwardly for thirty-five miles, the boundary then meeting the first steppe, an ancient shore-line, now called Pembina Mountain, much broken with ravines and gorges, through one of which, 850 feet deep, the Pembina River flows. After crossing this river the land ascends to the upper plateau, about 1500 feet above the sea-level, forming the commencement of the Great Plains, which extend for 700 miles to the base of the Rocky Mountains. These plains are in some places quite level, in others undulating, with numerous hillocks, sometimes 80 or 100 feet in height.

A clayey soil, with some admixture of sand, supports the short, wiry, and very nutritious buffalo grass. The first section of these plains east of Turtle Mountain is seventy miles wide, and is almost devoid of rainfall. Over it are scattered great boulders of granite and limestone from a glacial drift. In crossing Turtle Mountain, a curiously elevated and wooded district thirty-five miles wide, the boundary crossed sixty-five pieces of water, of which twenty-five are true lakes. The effect of this wooded area is very marked in attracting rainfall, while the surrounding plains are suffering from drought.

For a distance of 188 miles west of Turtle Mountain the Great Plains continue at an average elevation of 2000 feet above the sea, the only break in the monotony being the valley of the Mouse River, one or two miles wide, and 150 feet deep. The boundary then

crosses the second prairie steppe, called the Great Coteau, leading to a plateau about 2250 feet above the sea, broken up by ridges and hollows in every direction, but having farther to the westward a chain of salt lakes about fifteen miles long. This is the central water-shed of the continent, the Mouse River emptying into the Red River and Hudson Bay, while the watercourses farther on fall into the Missouri River and Gulf of Mexico. Here the "bad lands" begin, having a clayey and barren soil, with a very rugged and broken country extending more than 300 miles along the boundary.

At a point 500 miles west of Red River the country changes to an arid plain of sand, with a little soil. Here buffalo were first met with in great herds, and some fresh-water lakes with good pasture were found.

The arid plain extends from east to west for 150 miles, being crossed by the gorge of the Milk River, 300 feet deep. In the midst of this barren expanse, rising abruptly like a group of islands, is the mountainous cluster called the Sweet Grass Hills, or the Three Buttes, the boundary-line crossing the northern slope.

The peaks of this group are 6800 feet high, and from them the Rocky Mountain range, 150 miles distant, can be seen distinctly on a clear day. After crossing St. Mary's River, the boundary enters the fertile belt extending for twenty-five miles to the base of the Rocky Mountains, which rise abruptly to peaks 10,000 feet above the sea. The mountain region where the boundary crosses it is about twenty-six miles wide, and upon the summit of the water-shed, at an altitude of 6700 feet, is placed the monument marking the western limit of the work of the Northern Boundary Commission, and also the eastern limit of the boundary survey carried from the Pacific side.

The maps constructed from the data obtained by both the United States and the British Commission are upon a scale of two miles to the inch, there being twenty-four sheets in the series. A set of reconnaissance maps, on a scale of eight miles to the inch, will also be published in seven sheets, six of them showing the general topographical outline from the Rocky Mountains to the Lake of the Woods, and the seventh sheet showing the profile along the boundary.

Attached to the British part of the Commission as geologist was Mr. George M. Dawson, of Montreal, whose report (published in 1875) contains a full description of the geology, particularly complete in the discussion of the carboniferous deposit which extends from the Pembina Mountains nearly to the Sweet Grass Hills. His discussion is very valuable, as filling up the gap hitherto untraveled between the line of explorations made by Captain Palliser and Dr. Hector, in 1857, 1858, and 1859, along the Saskatchewan, and those of Professor Hayden and others along the Missouri.

Dr. Elliott Coues, the well-known naturalist, accompanied the

United States Commission in 1873 and 1874, and had unusual facilities in making collections in Natural History and Botany. These collections are now deposited in the Smithsonian Institution, and his report will form a separate volume.

The labors of the parties belonging to the "Geographical Survey of the Territories," under the direction of Professor F. V. Hayden, during the past season, have resulted in completing the survey of the mountainous portion of Colorado, with a belt of Northern New Mexico fifteen miles wide, and a belt in Eastern Utah twenty-five miles wide.

For the summer's work four field parties were organized, each accompanied by a topographer and a geologist, and a large amount of geodetic, topographical, and geological work was done, the details of which will be found in the body of the present work.

Six sheets of the Physical Atlas of Colorado are nearly ready for issue, covering an area of 70,000 square miles. The maps are constructed on a scale of four miles to the inch, with contour lines at intervals of 200 feet.

The United States Geographical Survey west of the 100th meridian, under the command of Lieutenant G. M. Wheeler, U. S. Corps of Engineers, has been prosecuted energetically, both as to field-work and in the arrangement and reduction of the mass of material accumulated. A detailed account of the results accomplished will be found in the body of this work.

Under the direction of Professor J. W. Powell, the exploration of the Rocky Mountain region has been carried on, as in previous years, under the auspices of the Secretary of the Interior. A large amount of triangulation and plane-table work was accomplished by the two topographical parties, which were separated from the geological parties, contrary to the custom heretofore. This method of operation gave increased facilities to both branches of the survey. An account of both topographical and geological work is published in the body of the work.

COSTA RICA.

The results of various surveys have been united by Mr. Friederichsen, Secretary of the Hamburg Geographical Society, in making an excellent map of the republic of Costa Rica. The map is on a scale of $\frac{1}{500000}$, or about $8\frac{1}{4}$ inches to a degree, and is far superior to any heretofore published of that country.

BRAZIL.

In a memorandum prepared to accompany a physical map of Brazil for the United States Centennial Exhibition, Señor Homem de Millo calls attention to the gross errors continually made heretofore in the representation of the mountain and river systems of the empire of Brazil.

The labors and investigations of Baron de Eschwege, Spix and Martins, Saint-Hilaire, and more recently Mr. Liais and Professor Hartt, afford material for a correct knowledge of the physical geography. The surveys made for railway lines have afforded valuable data, and very numerous astronomical observations for position and barometric observations for heights have been made. The results of all this work have been carefully embodied in a physical map, so that no excuse will remain for such gross inaccuracies as have existed heretofore.

PERU.

The first volume of the great work on Peru, by Don Antonio Raimondi, has been published. By this accomplished geographer and naturalist, Peru has for the first time been scientifically explored, Señor Raimondi having devoted a lifetime to the work. More than a quarter of a century ago he made his first journey from Lima across the Andes, and for nineteen years traveled over the country on a fixed plan, diligently collecting materials before beginning to preface his work for publication. The work will consist of six parts, the first being devoted to geography and meteorology, the second to geology, the third to mineralogy, the fourth and fifth to botany and zoology, and the concluding part to ethnology. The work is being published at the expense of the Peruvian government.

From observations made during a recent examination of Lake Titicaca, Peru, Mr. Alexander Agassiz concludes that within a comparatively recent time the Pacific Ocean extended through gaps in the Andes and formed an internal sea, the bottom of which is now at a height of 2900 or 3000 feet above sea-level. This is proved by the existence of coral limestone, similar to the West India formations at about this height, about twenty miles inland from the Pacific. Mr. Agassiz has prepared for publication a valuable hydrographic map of the lake from information obtained during his visit in 1875.

URUGUAY.

In the *Democracia* of Montevideo has appeared an excellent series of letters by Señor Clemente Barrial Posada, the geologist, describing the geology and geography of the interior of Uruguay. Taken in connection with the reports of Mr. Twite's mineralogical explorations in the province of Minas in 1875, these form valuable additions to our knowledge of Uruguay.

BUENOS AYRES.

The government of the Argentine Republic has commenced the publication in German and French of a physical description of that country by Dr. H. Burmeister, who has resided there for the past twenty years, and whose reputation as a geographer is a guarantee of the accuracy of his work.

PARAGUAY.

Our knowledge of the physical geography of Paraguay has been very much increased by the observations of Keith Johnston, Esq., and Lieutenant Congreve, R.N., during their extensive journeys in that country in 1874, notes of which were published in the Proceedings of the Royal Geographical Society in August last, and in the *Geographical Magazine* for September. Careful barometric and boiling-point determinations of heights were made at numerous places, being in all cases referred to the height of Asuncion above sea-level as a base, this being first ascertained with great care, and found to be 321 feet, instead of 253 feet, as heretofore supposed. The exact geographical position in latitude and longitude of about twenty points in the Argentine Republic and Paraguay have been fixed under the direction of Dr. Gould, of the Cordoba Observatory, the longitude being in all cases ascertained with reference to Cordoba by the exchange of time signals over telegraph lines. This work, which is being extended by Dr. Gould as fast as practicable, and which already includes Valparaiso on the Pacific and Montevideo on the Atlantic coast, will be of immense service in rectifying errors in maps already existing, and in furnishing bases for new surveys and explorations.

BOLIVIA.

In Bolivia valuable work is being done by Commander Musters, R.N., and Mr. Minchin, a civil engineer employed by the government in fixing the positions of important places, and in constructing maps of Bolivia. All the longitudes are referred to that of Sucre, the capital, a secondary meridian being established there 65° 17′ west of Greenwich. A scale of fifteen inches to a degree has been selected for their maps; and as the best now existing (made by Colonel Ordasa) is very erroneous, the work now being done will be of great value.

Besides numerous astronomical observations for latitude and longitude of important points, very many hypsometric and magnetic observations have been made.

The discovery, in Sept., 1876, of the rich silver deposits in the mining district of Caracoles, and the immensely rich guano beds of Mejillones, have attracted much attention to the hitherto unknown coast region of Bolivia. In Petermann's *Mittheilungen* for Sept., 1876, Dr. Hermann Wagner has well described this coast district, with the three great western terraces of the Bolivian Andes. Here as elsewhere the searches for practicable railway routes have added much to geographical knowledge.

EUROPE.

The Geographical Society recently founded in Madrid has resolved to devote its energies to the study of the Spanish peninsula

and of Spanish maritime possessions, the delineation of which on modern maps and charts is in a lamentably imperfect condition.

In the *Anuario del Observatorio de Madrid* for 1876 is published a notice, by Señor Miguel Merino, of all the most important voyages and geographical discoveries from the earliest time, commencing with the somewhat apocryphal date of the Deluge, B.C. 2400. Since the eighth century of the Christian era the work appears to have been done with great care, the discoveries of the Spanish and Portuguese navigators in the fourteenth and fifteenth centuries having received especial attention. The work deserves the notice of everybody interested in the annals of maritime discovery.

During the past year the government survey of Austria and Hungary has made marked progress. Nearly 150 sheets of the maps, on a scale of $\frac{1}{75000}$, are published or nearly ready for publication. A large number of places have had their longitude determined by telegraph; the exact longitude of Vienna, to which they are referred, being measured directly by telegraph from Greenwich. The Austrian Military Geographical Institute has also published a map of Bosnia, Herzegovina, Servia, and Montenegro in 182 sheets, on a scale of $\frac{1}{300000}$.

An important contribution to the history of geography has been made by the publication, under the auspices of the Royal Italian Geographical Society, of a bibliography of all geographical works, both books and maps, in the Italian language, with a biographical notice of all Italian explorers and geographers.

In no way is the increased interest in scientific geography shown more strongly than in the constant accessions to geographical societies already established, and in the formation of new ones. In Belgium and in Denmark during the past year new societies have been established under very promising auspices.

ICELAND AND GREENLAND.

Under direction of the Danish government, M. Steenstrup, a nephew of the eminent geologist of that name, accompanied by Lieutenant Holm, of the Danish navy, has sailed for Greenland, to commence the exploration of the district of Julianshaab and the interior east of that point. The first authoritative work on Greenland in the English language has been recently published. It is the work of Dr. Rink, for twenty years governor of South Greenland, and is one of the most valuable contributions to arctic geography which has been published for many years.

A Danish expedition has proceeded to Iceland, to explore, among other localities, the vicinity of the recent volcanic eruption. Professor Jonstrup, M. Fieldberg, surveyor, and M. Gronlund, botanist, have accompanied the party. In a paper before the Royal Geographical Society, Mr. W. L. Watts has given an account of a journey to

the Iceland glaciers, and stated that these glaciers are manifestly increasing in size from year to year, and, unless checked by a succession of warm seasons, seem likely to overwhelm the island.

ASIA.

In exploration, as well as in the publication of the results of previous travels, a great deal has been done during the past year toward increasing our knowledge of Asiatic geography. In this work the Russian Geographical Society has been energetic, several important expeditions having been, under its auspices, during the past year, either undertaken, continued, or brought to a conclusion. The most important of these, as well as the explorations carried on by travelers of other nations, may be briefly noticed.

The work of carrying a series of levels across Siberia from the European frontier to Irkoutsk, a distance of 3000 miles, under the direction of Colonel Tillo, has been completed, and the results will be shortly published.

The Olena expedition, in addition to the work noticed in the last *Record*, has, under command of the late M. Chekanovsky, explored the Lena and Olonek Rivers, and has examined the great northern *tundra** of Siberia. This appears to be essentially different from the marshy tundra of Western Siberia.

In addition to his geognostic and route surveys, M. Chekanovsky brought home a paleontological collection comprising 1600 specimens, all belonging to the secondary geological epoch, a herbarium containing more than 3000 plants, and an entomological collection numbering more than 7000 insects.

The shores of the Aral Sea and its affluent the Amu-Daria River have been surveyed by a Russian party, and careful magnetic, meteorological, and astronomical observations have been made. An important addition to the knowledge of this region has been made by the publication of "The Shores of Lake Aral," by Major Herbert Wood.

By direction of the Russian Minister of Public Works, M. Sidensner has visited Western Siberia, to ascertain the practicability of uniting the great river systems of the Obi and the Yenisei. He found that the Ket, an important branch of the Obi, afforded the greatest facilities for this undertaking, while his colleague, M. Lopatin, explored the geology of the basin of the Chulim, where he found iron ore. His researches further resulted in the discovery of animal and vegetable fossil deposits in several places on this river.

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* By the word *tundra* are denoted the immense plains in Russia and Siberia between the forest region and the Polar Sea. The ground, though almost every where continually frozen at a short distance below the surface, produces in summer a scanty vegetation.

An important step in the exploration of Central Asia has been made by the expedition to Hissar under the direction of M. Mayef. The party started from Karshi, in Bokhara, passing the Chakcha Valley and the famous gorge known as the Iron Gate, near Darband. This place had not been visited by Europeans since Clavijo's embassy to the court of Tamerlane in 1404. They visited the towns of Hissar and Faizabad, but were prevented by illness among the party from advancing, as had been intended, to the point of confluence of the Wakhsh and Panj Rivers, so as to fix its position astronomically. The maps, when published, will be of great interest.

The remaining unsurveyed portion of the Usboi, or old bed of the Oxus, has been explored and mapped by an expedition under direction of the Caucasus section of the Russian Geographical Society.

At a meeting of the Russian Geographical Society, March 15, 1876, M. Sosnovsky gave an account of his recent journey through China and Mongolia, by order of the Russian government, with the object of opening new markets for Russian trade with Asia, and exploring the route from Zaisang through Dzungaria and the province of Scechnen. The party set out from Kiakhta for Pekin, and reached Hankow in October, 1874. From here they ascended the Han-kiang River, and, after traveling 800 miles by water and 1900 by land, arrived at Zaisang, October 26, 1875, by way of Hanchung, Hami, Barkul, and Guchen. This route can not but be of the utmost importance as soon as a railway shall have been built as far as Tiumen and steamers navigate the Irtish River.

During M. Sosnovsky's journey the position of twelve points was determined by astronomical observations, complete series of magnetic observations were made at ten places, and the altitudes of numerous points determined by barometer or by boiling-point.

An account of the explorations by Lieutenant-Colonel Prejevalsky, during 1870, 1871, 1872, and 1873, in Mongolia and Northern Thibet, has been published during the past year. During the three years' work his party traveled more than 7000 miles, about half of which was laid down in routes surveyed for the first time. Numerous observations by barometer and boiling-point were made for altitude, and the route surveys were checked by eighteen determinations of latitude. The collection of plants, birds, animals, fishes, and insects was very large and valuable, many of the species being new.

Colonel Prejevalsky has commenced another journey through Turkestan and Thibet, the results of which will probably be also of great value. His party started from Kulja on the 22d of August, 1876, and, crossing the Thian-Shan Mountains, will proceed by way of Karashah to Lob-Nor Lake, where they will spend the winter. He will proceed to Lhasa, and explore the upper course of the Brahmapootra, the northern slopes of the Himalayas, Eastern Thibet, and Southwestern China, returning if possible to Russia by way of West-

ern Thibet and Kashgar. The expedition will make geographical and ethnographical researches, and a route survey. Positions will be determined astronomically, and collections made in all branches of natural history.

A survey of the coast of Eastern Siberia between the parallels of 45° and 52° N. has just been completed by Lieutenant-Colonel Bolschef. The undertaking was a very arduous one, as there is no land route along the coast, and in-shore navigation is always dangerous and frequently impossible, owing to the shelterless character of the coast and the heavy surf constantly beating upon it. The country is well watered, fertile, and heavily timbered. The fisheries are very productive and the mineral wealth is great: lead, silver, iron, copper, coal, and gold having been found.

An interesting report by Colonel Bolschef of the general results of this survey is contained in the July number of the *Isvestia* of the Russian Geographical Society,

A German expedition has been engaged during the past year in the exploration of Northern Siberia, under the leadership of Dr. Finsch, accompanied by Dr. Brehm and Count Waldburg-Zeil, of the Bremen *Polar Verein*. The details of their journeys are not yet published, but the expedition has returned to St. Petersburg after a successful summer's work. No less than seven additional scientific expeditions have been engaged in the exploration of Russian Asia, under the auspices of various Russian learned societies.

Petermann's *Mittheilungen*, Supplement No. 46, contains a valuable memoir on the Pekin plain and the neighboring mountain-land, by Dr. Breitschneider, being the results of observations during nine years while the author was serving as physician to the Russian embassy. His account of Pekin and its vicinity tends to confirm the reports of Marco Polo. Dr. Breitschneider affirms that, instead of one or two millions of people, from his own intimate knowledge of Pekin, its population does not exceed at most 500,000.

In the *Bulletin de la Société Géographique* the Abbé Armand David gives an interesting account of his travels in Western China from 1868 to 1870. His object was to ascend the Yang-tse River, and penetrate through the province of Sz-chuen into Thibet. In this he was disappointed, principally owing to ill-health, but his exploration of the Yang-tse affords much information of value as to the course of this great river and its tributaries.

In India the work of the great Trigonometrical Survey has been energetically carried on under the superintendence of Colonel Walker, R.E. An appendix to Colonel Walker's report for 1874 consists of the report, by Captain H. Trotter, R.E., on the secret journeys of Indian employés of the survey in trans-Himalayan regions. Under various pretexts and disguises, these officials, known as the Havildar, the Mollah, and the Pundit, have traversed hitherto unknown re-

gions, and have collected a mass of data, the results of which have been an immense gain to the geography of these regions. In the *Geographical Magazine* for January, 1877, will be found a sketch of the work performed during 1875.

The *Geographical Magazine* for October, 1876, contains an interesting article on the authorities used by Major St. John in constructing his map of Persia, in six sheets, on a scale of sixteen miles to an inch. His map exhibits solely the information derived from trustworthy European sources. A vast amount of information embodied in it is published for the first time, and the map is considered to be of the highest value.

The geographical results of a survey made in 1872 and 1873 of the routes for a railway to join the Mediterranean and Persian Gulf are published in a supplement to Petermann's *Mittheilungen*. The survey was made under the direction of Mr. Josef Cernik, who arrives at the conclusion that the route through the valley of the Euphrates is impracticable, and recommends a more circuitous line along the base of the mountains of Kurdistan, through Mosul, Diarbekr, and Aleppo to Alexandretta on the Gulf of Iskanderun, or Tarabulus on the Black Sea.

The amount of country surveyed in Palestine by the English expedition for that purpose during the past year is 1500 square miles, making a total of 3500, and leaving about 1400 square miles in Upper Galilee to be completed. A line of levels between the Sea of Galilee and the Mediterranean was commenced, but was interrupted by the hostility of the natives. It is hoped that the trigonometrical survey may be completed this year.

In February an expedition sent by the American Palestine Exploration Society, under charge of Dr. Selah Merrill, visited the valley of the Jordan and the eastern shore of the Dead Sea, devoting considerable time to the section at the northeast corner of the Dead Sea and the mounds that exist there, with reference to the geography of portions of the 13th chapter of Joshua and the 32d chapter of Numbers.

AFRICA.

The details and results of the journey of Lieutenant V. L. Cameron, R.N., across Africa in 1873, 1874, and 1875, have been published during last year, and entitle him to very high rank as a scientific explorer. The original object of the journey being to search for and succor Dr. Livingstone, the expedition commanded by Lieutenant Cameron left Zanzibar for the interior in March, 1873, and upon hearing, in October of the same year, of Dr. Livingstone's death, pushed on to Lake Tanganyika, to secure the effects of the deceased explorer at Ujiji. This he succeeded in doing; and taking such instruments of Livingstone's as were needed to replace those lost and injured during his journey from the coast, Lieutenant Cameron pre-

pared for his western journey. After examining a portion of the shores of Lake Tanganyika, he turned to the northwest and reached Nyangwé, an important commercial town, in south latitude 4° 12′, east longitude 26° 31′, in the autumn of 1874. Careful astronomical observations were made here to determine a starting-point for further exploration, Lieutenant Cameron's intention being to follow the banks or valley of the Lualaba River, an affluent of Lake Tanganyika, so as to prove its identity with the Congo; but this was found, from want of boats and from native hostility, to be impracticable, and he was obliged to pursue a more southerly track. Having proceeded as far as the tenth degree of south latitude, Lieutenant Cameron turned to the westward, and, passing along the water-shed between the tributaries of the Congo and the headwaters of the Zambesi, arrived after much delay and trouble, on November 4th, 1875, at the Portuguese settlement of Benguéla, on the western coast. Among the most important of the discoveries during this long journey was that of a hitherto unknown but extensive water system, formed by a river flowing through a series of lakes intermediate between the Lomamé and the more eastern valley which Dr. Livingstone had followed up from Lakes Bangwealo and Mœro. The whole country between Nyangwé and Lake Dilolo, a distance of over 600 miles, is new ground, as, although the Lulua, the Luburi, and other rivers crossed by Lieutenant Cameron had been heard of before and the country had been traversed, he was the first to fix their true position on the map. He ascertained that at Nyangwé the Lualaba River is only 1400 feet above the sea, proving that this great water system can have no connection with the Nile, that river being at Gondokoro 1500 feet above sea-level. There seems to be no reasonable doubt that the Lualaba and the Congo are identical. The information collected by Cameron explains a great deal of Dr. Livingstone's memoranda which would otherwise be unintelligible.

One of the principal geographical results of the journey has been the construction of a section of elevation across the entire continent of Africa between the fourth and twelfth degrees of south latitude, verified throughout by careful astronomical observations. Lieutenant Cameron's diligence and skill in taking observations (over 5000 being made for latitude, longitude, and elevation), and the general success of the journey, have earned for him his promotion in the Navy to the rank of Commander, and the award of a gold medal from the Royal Geographical Society.

The expedition sent out by the German African Society to penetrate into the interior from the west coast has not thus far been very successful.

Dr. Otto Lenz, who had hoped to follow the course of the Ogowé River, and who had so far succeeded as to overcome the opposition of the inhabitants of the Oscheba lands, has been obliged to return

to Europe in consequence of ill-health. The only remaining members of the expedition, Dr. Paul Pogge and Mr. Edward Mohr, are exploring the Angola coast, which is to serve as the starting-point of their respective journeys.

An expedition under command of Count Pietro di Brazza, and conducted at his own expense, has commenced exploration by way of the Ogowé River. The party started from Gaboon, and was furnished by the French authorities there with an escort of seventy colored soldiers. The party had at last advices succeeded in penetrating to Okanda, 500 miles from the mouth of the Ogowé River. This place will be used as a starting-point for explorations into more unknown regions.

Colonel Gordon, R.E., who has been engaged in the exploration of the Upper Nile, has been most persevering in his efforts to find a navigable channel to the Albert and Victoria N'yanza. Proceeding up the Nile with a portable steamer and boats, progress was stopped by the Tola Falls or Rapids in about 4° north latitude. He therefore left the river and proceeded by land to the Victoria and Albert N'yanza, taking possession of both lakes for the Khedive of Egypt. Then returning to Dufflé, above the rapids, he found the steamer and boats, which had been carried piecemeal by the falls, and dispatched M. Gessi up the river to the Albert N'yanza, which was entered and circumnavigated, and found to be one hundred and forty miles long and fifty miles wide. An ineffectual attempt has been made to find among the numerous diverging branches of the White Nile some stream which may carry boats round the Tola Rapids. As all these branches have not been examined, Colonel Gordon thinks that water communication between Khartoum and the Victoria N'yanza may be established.

The circumnavigation of Lake Nyassa by Mr. E. D. Young has been accomplished, and the discovery made that the lake extends 100 miles farther north than was supposed by Dr. Livingstone. No bottom was found with 100 fathoms of line. A further examination of the lake and of its shores will be made.

Mr. H. M. Stanley is still pursuing his explorations in Central Africa, but no precise details of his travels since the publication of the *Record* for 1875 are available to determine what additional geographical information has been collected.

A large portion of Mr. Stanley's labor has been devoted to the exploration of the country hitherto unknown between the two lakes Victoria and Albert N'yanza.

A geographical conference regarding the exploration of Africa took place at Brussels, September 12th, and was attended by numerous African explorers as well as eminent geographers from several European states. The conclusions arrived at were in general that stations should be established on the coast and in the interior available to explorers as bases to start from.

It is intended to limit the field of international exploration to the region bounded on the east and west by the Indian and Atlantic Oceans, and on the north by the frontiers of the Egyptian territory and independent Soudan.

AUSTRALIA.

An account has been recently published of explorations made in Southern and Western Australia in 1875 by Mr. Ernest Giles, already distinguished in Australian discovery. The expedition started July 27, 1875, from Youldeh dépôt, 185 miles N.N.W. from Fowler Bay, near the border of the known region of South Australia. The first important discovery was the well of Oldabinna, an open space in the scrub bush which surrounds it. Moving westward from this place an utterly waterless country was entered upon covered with dense bushes. Five hundred miles were traversed before any water was obtained, and the region was utterly uninhabited by man or animal. After passing this desert another was traversed, after which a region occupied by hostile natives was crossed, the expedition finally arriving in November at Perth, Western Australia. The whole journey covered 2500 miles, in which not one area fit for settlement was found. The line traversed lies between the route of Eyre in 1840 and Forrest in 1870.

Mr. Giles has during the winter season of 1876, from April to August, accomplished a return journey, during which he traced the Ashburton River to its sources, and determined the water-shed of the western rivers, which he describes as simply a mass of rangy country, abutting upon the desert in east longitude 120° 20′. No watercourses were found to flow eastward from the end of the water-shed in that longitude. During the journey the longest time the party were without finding water was ten days. They experienced an excessively cold winter, the thermometer in the morning being for weeks down to 18°.

NEW GUINEA.

The shores of New Guinea have continued to afford subjects of interest to the explorer and naturalist. At the expense of the Genoese authorities, Signor Odoardo Beccari has been engaged for some years past in explorations in this vicinity, and has completed an important geographical work. In exploring the coast of Northwestern New Guinea he has discovered a river called Wa Samson, flowing from east to west for a distance of 215 miles, and affording the principal drainage of this part of New Guinea. He has also examined Geelvink Bay, which separates the northwestern peninsula from the mainland, and has made an important rectification of its coast-line on the charts, shifting it to the northward in some places as much as thirty miles. Until Signor Beccari's visit, the hydrog-

raphy of this part of the island was based on an old Dutch chart of 1705.

The Fly River has been explored by Mr. S. Macfarlane, accompanied by the Italian naturalist, Signor D'Albertis, in a steamer to a distance of 150 miles from the mouth. This is the first positive knowledge that the river is really navigable, and Mr. Macfarlane considers it probable that they could have proceeded much farther but for fevers which attacked nearly all the party. The land was low and swampy, and the population scattered.

Signor D'Albertis proposes to revisit this vicinity and explore the Fly River to the head of navigation, and from that point to cross the country to Yule Island. The Chamber of Commerce of Sydney have undertaken to assist him, and have furnished him with a steam launch.

Mr. Octavius Stone, one of the explorers of the Baxter River, has been continuing his labors from Port Moresby to the eastward of the Papuan Gulf. The low country of the coast seemed to be bare, luxuriant vegetation only being found where the mountain ranges rise and intercept the rainfall. Mr. Stone, in a recent communication to the British Association, remarks that the neighborhood of the Baxter River and the shore west of the Papuan Gulf for 100 miles inland are swampy, covered with mangrove trees, and thinly populated. The climate of the western coast is peculiarly fatal to Europeans, but the eastern peninsula is warm and healthy.

Dr. Miklucho-Maklay is engaged in exploring the group of little-known islands lying between New Guinea, New Ireland, and New Britain.

HYDROGRAPHY.

By Lieutenant-Commander F. M. GREEN, U. S. N.

The most strongly marked feature of hydrographic work for the past year is the careful exploration of the depth and temperatures of the sea, and of the nature of the bottom. Americans, English, Germans, Norwegians, and Chilians have all added much to our knowledge in this direction.

The United States Coast Survey has done valuable work of this kind in the Gulf of Mexico, where very numerous soundings and temperature observations have been made to determine the contour of the bottom and of isothermal surfaces. In addition, the work of completing the hydrography of those portions of our coasts not yet thoroughly examined, and of re-examining the localities liable to change, has been diligently prosecuted.

On the Atlantic coast surveying work has been done at Deer Island and Saco Bay, on the coast of Maine; on the coast of New Jersey, in Delaware Bay, in Albemarle and Pamlico Sounds, on the coasts of South Carolina, Georgia, and Florida, and on the Florida Reefs.

On the Gulf coast extensive work has been done on the coasts of Florida and Louisiana, including observations of currents, volume of discharge, differences of level, changes of depth, etc., at the mouths and bars of the Mississippi River.

On the Pacific coast the survey of the coast-line of Northern and Southern California, as well as that of Oregon and Puget's Sound, has been carried on.

In the prosecution of these surveys nineteen parties have been engaged on board of the same number of small vessels, nine of this number being steamers and the rest sailing-vessels.

The work of compiling a "Coast Pilot," or sailing directions for the Atlantic coast, has also steadily progressed.

The United States Hydrographic Office has continued the routine work of exchanging hydrographic information with foreign hydrographic offices, and of publishing promptly all notices which might be of use to our mercantile and naval marine. From the hydrographic offices of England, France, Germany, Italy, Russia, Spain, Austria, Denmark, Sweden, Portugal, Holland, Brazil, and Chili, information as to dangers discovered, or as to the establishment of aids to navigation, has been constantly received, translated, and examined, while to these governments, as well as to chambers of commerce, marine insurance offices, and prominent newspapers at the

principal ports, all such information coming to the knowledge of the office is communicated. Seventy-five notices to mariners, embodying information of changes in artificial aids to navigation, have been published, as well as sixty-nine hydrographic notices of newly discovered features in the earth's surface.

As far as the limited appropriations made by Congress would permit, new charts have been engraved and published.

Sailing directions for the Pacific Ocean, the west coast of Africa, a part of the coast of the Mediterranean, the Bay of Biscay, the West India Islands, and for the coasts of Chili, Peru, and Bolivia, have been published during the past year, or are ready for publication.

Under direction of the Navy Department, the U. S. steamship *Tuscarora*, Commander J. N. Miller, has examined the depth of the Pacific Ocean from the Sandwich Islands to the Fiji group, and thence to Brisbane, Australia; to determine if the laying of a telegraph cable is feasible from California to Australia. In the performance of this work one hundred and seven soundings were made with steel wire. Specimens of the bottom were obtained from nearly every sounding, and are now being examined. Of these soundings the deepest was 3448 fathoms; there being nineteen of less than 1000 fathoms, thirty-eight of from 1000 to 2000 fathoms, thirty-two from 2000 to 3000 fathoms, and eighteen of over 3000 fathoms.

The observations for the determination of secondary meridians in the West Indies have been completed by the officers of the U. S. steamship *Gettysburg*.

The undertaking of systematic determinations of longitude by the electric telegraph, wherever submarine cables extend, thus commenced by the U. S. Navy Department, has received much attention and commendation from foreign officers.

During the homeward voyage of the *Gettysburg*, deep-sea soundings were made in the intervals between those previously made by H. B. M. steamship *Challenger*, in every case confirming the *Challenger's* work.

In consequence of errors known to exist in the geographical positions of the north coast of South America, the U. S. steamship *Huron* has been ordered to determine the longitudes of about thirty stations along that coast, measuring the longitudes by chronometer from the meridians of Port Spain (Trinidad) and Aspinwall, previously determined with great exactness by telegraph.

The U. S. steamship *Gettysburg*, while engaged in searching for doubtful dangers in the eastern part of the North Atlantic Ocean, has discovered a remarkable coral bank, about five miles in extent, lying about one hundred and thirty miles to the westward of Cape St. Vincent. The least water found on the bank thus far is thirty-four fathoms, but there is probably less.

The English have as usual performed by far the largest portion of the hydrographic work of the past year. Under the direction of the British Hydrographic Office, surveys of a permanent character are being carried forward on the shores of England, Ireland, the Gulf of St. Lawrence, Newfoundland, Labrador, Jamaica, Mauritius, the east coast of Africa, Japan, Australia, and the Fiji Islands, while detached surveys have been made in the Mediterranean, on the coasts of China, and among the Pacific islands. Interesting results have been derived from the examination by British surveyors of the Mediterranean entrance of the Suez Canal, the approaches to which do not seem to have shoaled as much as was anticipated.

Since the publication of the *Record* for 1875, the admirable work done by the English surveying-ship *Challenger* has been brought to a close by her arrival at Spithead on the 24th of May, 1875.—Resuming the sketch of her cruise where it was left in the *Record* for 1875, the ship, after refitting, left Yokohama on the 11th of May, 1875, for a short cruise of about three weeks to Kobe and the Inland Sea, where some dredging was done, but without much success. The expedition finally left Japan on the 16th of June, and, constantly dredging and sounding in depths of from 1875 to 3950 fathoms, arrived at Honolulu, Sandwich Islands, on the 27th of July. The soundings between Japan and the Sandwich Islands were quite uniform in depth, the average of twenty-two being 2858 fathoms. The bottom was generally red clay, frequently filled with concretions of peroxide of manganese from the size of a grain of mustard seed to that of a large potato. These concretions were formed by concentric layers, starting from a nucleus consisting of some foreign body like a shark's tooth or a bit of pumice.

On the 11th of August the *Challenger* proceeded to the island of Hawaii, where the volcano of Kilauea, then in eruption, was visited, and good photographs were obtained of it. On the 19th of August the ship sailed for Tahiti, arriving there early in September. Many soundings and dredgings were made on the way, with an average depth of 2800 fathoms; the bottom being generally of red clay, and many things of great interest to the biologist being discovered.

Leaving Tahiti on the 2d of October, Juan Fernandez, at a distance of 4000 miles, was reached on November 18th, the section between the two places having an average depth of 2160 fathoms.

From Juan Fernandez the *Challenger* sailed for Valparaiso, sounding, trawling, and taking serial temperatures constantly. From Valparaiso the homeward voyage was commenced on the 11th of December, *via* the Strait of Magellan, where some valuable additions were made to the naturalists' collections, the ship reaching Port Stanley, Falkland Islands, January 23d. While here, magnetic observations were made at the exact spot where Sir James Ross's magnetic observatory was established in 1842, when it was discov-

ered that the inclination of the magnetic needle had changed from 48° 26′ in 1842 to 52° in 1876.

Leaving the Falkland Islands on the 6th of February, the *Challenger* proceeded to Montevideo, then to Ascension, Porto Praya, St. Vincent, and Vigo Bay, the work of sounding, dredging, and taking serial temperatures being steadily and faithfully kept up. From Vigo the ship sailed for England, arriving at Spithead on the 24th of May.

During this long and admirably conducted cruise the *Challenger* sailed and steamed more than 69,000 miles. Nearly 400 deep-sea soundings were made, of which two were over 4000 fathoms, nine between 3000 and 4000 fathoms, one hundred and sixty-eight between 2000 and 3000, one hundred and twenty-four between 1000 and 2000, and the remainder were under 1000 fathoms. Serial temperatures of the ocean were obtained at 250 stations, and dredging was effected at nearly as many. In addition to this work done at sea, very many anchorages were surveyed, and numerous additions and corrections made on the charts of the coasts visited.

H. B. M. S. *Valorous*, after parting from the arctic ships *Alert* and *Discovery* on the 17th of July, 1875, and stopping *en route* at Holsteinborg, returned to Cork. During the three months' cruise of the *Valorous*, in addition to the chief duty of supplying the Arctic Expedition, much valuable hydrographic work was accomplished. No less than fifty-seven deep-sea soundings were made in Davis Strait and the Atlantic; dredgings which have yielded important results were made in hitherto unexplored regions; valuable observations of temperatures at different depths were made; and several harbors, including Holsteinborg with its approaches, were surveyed. The Atlantic soundings indicate that there is a cap or ridge with only 690 fathoms upon it, and with comparatively steep sides, at a distance of about 400 miles southeast of Cape Farewell.

Upon parting company with the *Valorous* off Disco Island on July 17th, the *Alert* and *Discovery* took their way to the northward, first encountering the ice of the middle pack on the 24th of the same month, but passing through it without difficulty in thirty-four hours. After visiting Port Foulke and Life-boat Cove, the scene of the wreck of the *Polaris*, the ice was met on July 30th off Cape Sabine, and from this point a constant struggle with it took place until August 25th, when, after many narrow escapes from being crushed, the vessels reached a harbor on the west side of Hall's Basin, in latitude 81° 44′ N. Here it was decided to leave the *Discovery*, and she was accordingly secured in sight of Polaris Bay, on the opposite side of the channel. The *Alert* pushed on to the northward, attaining a latitude of about 82° 30′ north, farther than any ship had previously reached, when she was beset by the ice, and, sheltered by some bergs which had grounded in twelve fathoms of water, the ship was secured for the

winter about three miles to the northward of the entrance to Robeson Channel. This, although a disappointment at the time, was probably fortunate, as the winter's observation indicated that, had a more northern latitude been attained, the *Alert* would have been so embedded in the ice that no amount of labor would have extricated her. Instead of an open Polar sea, the ice was jammed together in masses of extraordinary thickness like icebergs, in some instances being from 150 to 200 feet thick, doubtless the accumulations of many winters.

Upon its being evident that farther northern progress with the *Alert* was not to be hoped for, the sledge work was commenced with marked promptness and energy, exploring parties being sent from the *Alert* to the north, northeast, and northwest, and from the *Discovery* to the opposite Greenland shore. The sledge parties established dépôts of provisions for the expeditions to be sent out the next spring, but experienced much hardship and suffering. The winter was unusually long, cold, and dark, the sun being absent for 142 days, and the temperature reaching 73.7° below zero, early in March, on board the *Alert*, the *Discovery* at the same time registering 70.5° below zero. Magnetic, meteorological, and astronomical observations were regularly made during the winter, and many expedients were successfully resorted to on board both ships to break the dreary monotony, till, on March 1st, the sun again appeared, and preparation for exploration by sledging parties was begun. By the beginning of April every man, except those absolutely necessary for the care of the ships, had departed, expeditions being sent in every direction, those from the *Discovery* turning their attention principally to the exploration of the western and northern coasts of Greenland.

A party under command of Commander Markham proceeded northward. Their progress was most difficult, owing to the roughness of the ice, but they reached a latitude of 83° 20′ 26″, finding under the ice a depth of seventy fathoms of water. No land was visible to the northward from this point.

To the westward of the *Alert* the coast-line was examined for 220 miles by a party under command of Lieutenant Aldrich, the most northern land found being in latitude 83° 7′ N., longitude 70° 30′ W.

On the Greenland shore, parties from the *Discovery*, under command of Lieutenants Beaumont and Rawson, explored the coast-line to the northeast, the farthest land found in this direction being in latitude 82° 54′ N., longitude 48° 33′ W., apparently almost identical with the Cape Sherman of the American charts. This coast is much cut up with fiords and inlets. Lady Franklin Sound and Petermann Fiord were also examined, the former being found to terminate sixty-five miles from the mouth, and the latter to be blocked up with a low glacier. This examination completes the shores of Smith Sound, except Hayes Sound.

President Land, marked on recent charts as in latitude 84° N., is shown not to exist, the land at the northern entrance of Robeson Channel trending sharply to the westward from Cape Union.

In spite of every precaution the sledge parties suffered dreadfully from scurvy, but showed the utmost fortitude and self-devotion. Fortunately only four deaths took place, three from this disease and one from frost-bite. The prevalence of this malady, and the very clear demonstration that no new discoveries were to be anticipated from protracting the stay of the expedition through another winter, decided Captain Nares to proceed to England as soon as the advancing season should liberate the ships. The *Alert*, however, was bound fast by the ice till July 31st, when a start was made, the *Discovery* being reached after much difficulty and danger. On August 20th both ships commenced their homeward voyage; but it was not till September 9th that, by clearing the ice and reaching open water, a certainty was assured of avoiding another winter in these dreary regions. Both ships reached Queenstown on October 29th, and after a few days proceeded to Portsmouth.

The results of the various observations, physical and meteorological, can not, of course, be known for some time, but will doubtless be very important. Large collections of natural-history subjects were made, among them some fine fossil corals, and the dredge and trawl were used several times with great success.

This is not the place to discuss the general results of the expedition; but its whole conduct is an ample guarantee that, when published, they will be in an eminent degree interesting and trustworthy.

In connection with arctic research, Lieutenant Weyprecht, of the Austro-Hungarian expedition, points out in an address delivered at Grätz, in September, 1875, the advantages which would accrue from the establishment of fixed observatories at various points over detached expeditions, which devote the best part of the year to sledge journeys. Arctic research he considers of the highest importance, but points out that independent series of observations, especially if chiefly devoted to geography, have but little value compared with stationary observatories encircling the arctic lands, and working on synchronous magnetic-term days and other agreed times.

These considerations have been fully presented by the German commission to which the subject was referred, with Lieutenant Weyprecht as a member. The commission also urges that a proper understanding be had between different nations, so that the labor of one party need not be duplicated by another.

An important contribution to arctic discovery is made by the publication, in Petermann's *Mittheilungen*, of the finished map and description of Franz-Joseph Land, discovered by the second Austro-Hungarian expedition in 1873. Hitherto only an outline sketch

has been published, but this one is based on the results of Lieutenant Payer's barometric observations for elevation. The land is not unlike Spitzbergen, and is composed of several groups of islands. Franz-Joseph Land exhibits the full rigor of arctic latitudes. In the beginning of spring, especially, every thing is covered with ice.

It is known that Northeast Greenland, Nova Zembla, and Northern Siberia exhibit signs of a slow process of rising from the sea. It was, therefore, very interesting to the voyagers to observe proofs of elevation in well-marked drift terraces. Vegetation is very scanty.

The recently organized Marine Survey of British India, under the superintendence of Captain A. D. Taylor, has been carried on in an energetic manner, a large amount of work having been done in surveying the approaches to Rangoon, Maulmain, the Bassein River, and Akyab.

Several important coast charts have been published, as well as sailing directions for the Bay of Bengal, and a most important series of hydrographic notices have been commenced.

Exceedingly valuable as the results of all these English surveys are, they have been dearly purchased at the cost of the lives of several of the officers making them, four at least in different parts of the world having fallen victims to overwork and the unhealthiness of the climate where their duties led them.

The German Hydrographic Office, although very recently organized, has aided largely during the past year in the collection and distribution of valuable information. The *Annalen der Hydrographie* for the year contain abstracts of the journals of various voyages of German men-of-war, whose commanders have lost no opportunity of deep-sea sounding, correcting charts and sailing directions, or of redetermining untrustworthy geographical positions. Prominent in this work has been the corvette *Gazelle*, a portion of the scientific staff of this vessel being the observers of the transit of Venus at Kerguelen Island. The expedition left Kiel June 21, 1874, and proceeded by way of Madeira, Porto Praya, Monrovia, Ascension, the Congo River, and Cape of Good Hope to Kerguelen Island, sounding, dredging, and taking serial temperatures at sea whenever an opportunity offered. The most remarkable discovery during the outward voyage of the *Gazelle* was that the soundings in the vicinity of the Cape de Verde Islands indicated that the islands form parts of the rim of an enormous submarine crater, similar in form to the crater of an isolated volcano.

During a stay of more than two months at Kerguelen Island, in addition to other work, a hydrographic survey of the northeast coast of the island was made, this vicinity having been almost unknown hitherto.

From Kerguelen Island the *Gazelle* proceeded to Mauritius, and thence to Western Australia, Timor, and Amboyna, constantly mak-

ing observations at sea of depth, temperature, and currents; and when in port making use of every opportunity of correcting charts.

Leaving Amboyna on the 11th of June, 1875, the northeast coast of New Guinea, with the adjacent islands, was visited and explored; the expedition next visiting Western Australia, New Zealand, the Fiji and Samoan groups. Passing from the Pacific Ocean through the Strait of Magellan, at Montevideo the English exploring-ship *Challenger* was met. From Montevideo the *Gazelle* sailed for home, arriving at Kiel on April 28, 1876. Differing from the famous cruise of the *Challenger* only in extent and duration, the observations made during the cruise of the *Gazelle* promise equally important results.

Within a short time ships of the English, German, and United States navies have determined the exact depth of the ocean in more than 1200 places where it was previously unknown.

The French *Dépôt des Cartes et Plans de la Marine* have published numerous valuable charts and sailing directions, the most important of the latter being a minute description from recent surveys of the island of Guadeloupe. The most important survey made during the past year by French naval officers has been the survey of the shores of the Gulfs of Sidra and Gabes on the north coast of Africa. These shores, between Sfax and Benghazi, have not heretofore been regularly surveyed, owing to the barbarity of the inhabitants and the shelterless character of the coast, and it was with great difficulty that Captain Mouchez, the officer charged with the work, was able to complete it.

The Chilian government have done excellent service by their recent establishment of a hydrographic office, much valuable information having been already collected and published.

The Chilian corvette *Ancud* has made a series of deep-sea soundings between Valparaiso and Caldera, preparatory to the laying of a telegraph cable between these two points. The west coast of South America affords a wide field for hydrographic work, and there is every reason to hope that the work so well begun by the Chilian government will be continued.

Japanese officers have made useful surveys principally of harbors on the coasts of the larger islands of Japan, and also among the off-lying groups to the southwestward, notably at Oösima Island and the Meiaco Sima group.

Many of these surveys are published by the Japanese authorities in a form useful for navigators of other countries.

The Norwegian deep-sea sounding expedition in the *Vöringer* has done good work during the summer. Leaving Christiansund on June 27th, sounding and dredging was carried on between Norway, the Faroë Islands, and Iceland very successfully. The scientific results of the expedition are already considerable; the animal life exhibiting a much greater variety than was expected, although the

depths and distribution of temperature were not very different from the anticipations previously formed.

Magnetic observations were made at various points in Iceland and the Faroë Islands.

Under the leadership of the celebrated arctic explorer Professor Nordenskjöld, an expedition has been at work during the past summer having for its main object the survey of the navigable waters between the Obi, Yenisei, and Norway.

This work has been successfully completed, and Professor Nordenskjöld states that the navigability of the rivers may be considered as practically established, and that it is practicable to maintain trade communication between the different portions of the Kara and the Yenisei.

The Kara Sea was found free of ice between September 2d and 7th, and a new island was discovered at the mouth of the Yenisei, in 73° N. latitude, which has been named Sibiriakoff Island. On both sides of it the water is deep and free from shallows, and the island will form a valuable protection against northwest winds and sea.

Professor Nordenskjöld concludes his interesting report of his summer's work by expressing his conviction, shared by the walrus-hunters whom he consulted, that a regular sea communication between Siberia and Northern Europe during a short season of the year ought not to be attended with greater risks and dangers than seamen encounter on many other waters now yearly visited by thousands of vessels.

ANTHROPOLOGY.

BY OTIS T. MASON,
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Anthropology is either descriptive or deductive. Descriptive anthropology gives an account of investigations concerning extinct or extant tribes of men. The former study is also called Archæology, and may be either prehistoric or classical; the latter is called Ethnography. Deductive anthropology embraces all discussions relating to mankind, including the study of his geological, zoological, and geographical origin, his primitive and subsequent somatical and psychical conditions and variations, the influence of environment, and the progress of culture. A complete account of the subject would also include a description of the various instrumentalities of research, and apparatus for observation and measurement, an accurate terminology, instructions to observers, a report of local and general meetings and international conventions, and a catalogue of all "transactions," private collections of merit, museums, periodicals, and books devoted to anthropology.

The following summary is arranged upon the order just mentioned; but, to avoid repeating much that has occurred in former volumes of the *Annual Record*, and on account of the limited space allotted to each summary, many of the headings will have to receive a brief consideration.

I. ARCHÆOLOGY.

North America.—Mr. William H. Dall read before the Washington Philosophical Society, January 31st, a long and carefully prepared paper upon "A Succession of Shell-heaps in Alaska." The author found in the mounds three layers, which he named, respectively, the echinus layer, the fish-bone layer, and the mammalian layer; and holds that these represent three grades of culture which have been developed in this region. Adolphe Pinart recently announced to the French Geographical Society his discovery of mounds upon the southern portion of Vancouver Island different from the shell-heaps of the coast.

At the last meeting of the American Association, Mr. G. H. Perkins read a paper upon "The Ancient Pottery of Vermont." At the same meeting, Mr. Henry Gillman made three communications, entitled "Peculiarities of the Femora from Tumuli in Michigan," "Some Observations on the Orbits of the Crania from the Mounds," and "Investigation of the Burial Mound at Fort Wayne, on the Detroit River, Michigan."

The Proceedings of the Davenport (Iowa) Academy of Natural Sciences, Vol. I., covering the period from 1867 to 1876, is a publication worthy of the highest praise. The zeal of the members of the society, and the generosity of its lady friends, are alike commendable. The archæological contributions relate principally to Ohio mounds; and the most noteworthy feature of their relics is the frequency of copper celts, some of which are found wrapped in a coarse cloth.

The archæology of Missouri is discussed in the third volume of the Transactions of the Academy of Sciences at St. Louis.

In the *American Naturalist* for February, Dr. C. C. Abbott defends the existence of a palæolithic and a neolithic age in New Jersey. The shell-heaps are traced back to a period 6000 years before Columbus.

Cave explorations have been made in Pennsylvania by Professor Haldemann and Professor Baird. They have yielded no evidence of the existence of man beneath the stalagmite. Bone implements and fine stone implements have been discovered, and some slight indications of cannibalism.

The mound-builders have been discussed in a pamphlet by Mr. G. S. B. Hempstead, of Portsmouth, Ohio; in contributions to the *Scientific Monthly* of Toledo, by Mr. Charles Whittlesey; and in a paper read by Hon. Lewis H. Morgan before the National Academy, in April, and published in the *North American Review* for July. The last-named memoir is worthy of the cautious and exhaustive pen of our countryman. "The mounds are considered as dwelling sites of 'village Indians.' The embankments, if reformed, would resemble a railway grade with a summit platform. These were the sites of the houses. The buildings were of timber, on the summit of the embankments, thus making a continuous, sloping rampart twenty feet high." Mr. Morgan reproduced in drawings the ground-plan of the structure, and an ideal reconstruction of a mound-builders' village.

Mr. Charles M. Wallace, of Richmond, Virginia, contributes to *Silliman's Journal*, No. III., 1876, an article upon flint implements which the author claims to have found in the stratified drift in the vicinity of that city. Whether they are of human origin or not, they are useful as throwing light upon similar objects found in other places.

The subject of pigmy graves in Tennessee and Kentucky is revived in our popular journals, and we are informed that many intelligent persons still believe in the former existence of such a race. The whole matter is set at rest, however, by the investigations of Jones, Clarke, Haskins, and Troost, a review of whose labors will be found in *Harper's Magazine* for December, 1876.

No. IV., Vol. I., of the Memoirs of the Peabody Academy of Science contains the essay of Professor Jeffries Wyman upon the "Fresh-water Shell-mounds of the St. John's River, Florida." The work of

publication was superintended by Professor F. W. Putnam. In addition to the ordinary finds in such localities, some striking facts are elicited. "The mounds contain human bones, broken up in the same way as the bones of edible animals, and are believed to be the remains of cannibal feasts. They contain fragments of the bones and teeth of extinct animals, as the mastodon, elephant, horse, ox, turtle, manatee, and a cetacean. These have undergone changes which show that they were not contemporaneous with the builders of the mounds."

The Ninth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology gives an account of the work done during the year, the report of collections and distributions, and an index to all the volumes of the series. The portraits of Mr. Peabody and Jeffries Wyman accompany the work. Professor Hayden has issued during the year No. I. of the second volume of his *Bulletin*. It is devoted almost wholly to archæology and anthropology. The articles are by Messrs. Holmes, Jackson, Bessels, and Barber, and contain profuse illustrations of the cliff-dwellings and the old Pueblo pottery. The Professor has also had plaster models made of the best preserved cliff structures.

Dr. Palmer has sent to the Smithsonian Institution an account of a mound excavated near St. Georges, Utah, which gives evidence of having been built up by reconstructing dwellings over the sites of those which had been burned, possibly on account of desertion at the death of the former occupant.

Principal J. W. Dawson read before the Victoria Institute, London, March 20th, a paper entitled "Fossil Agriculture in America."

The Geographical Society of Lyons publishes a paper, by M. Émile Guimet, upon the "Origin of the Ancient Mexicans." The object of the pamphlet is to overthrow the theory that relics of Egyptian influence are traceable in Mexican remains.

The most notable publication of the year upon North American archæology is a profusely illustrated work by Dr. Charles Rau, based upon the specimens in the National Museum. It has been issued by the Smithsonian Institution among the "Contributions to Knowledge." The archæological exhibition at the Centennial, under the direction of the same gentleman, has been the means of doubling the material and value of the national collection.

Middle America.—In the Proceedings of the American Philosophical Society, 1875, is a long and elaborate article on the Indians of Costa Rica, which makes several allusions to the antiquities of that country. Mr. Hyde Clarke's paper, read before the London Anthropological Institute, July 25th, on the "Worship of Siva in Central America," opens a new field of thought with reference to American mythology.

A paper upon the "Antiquities of Porto Rico" was read before the American Association by O. T. Mason, based upon the generous gift of Mr. George Latimer to the Smithsonian Institution, mentioned in the last volume of the *Record*.

South America.—Das Ausland, for April 24th, commences a series of articles upon ancient Peru, and Macmillan & Co. have in press a volume, by Mr. E. G. Squier, upon the same subject. J. J. von Tschudi has published in Vienna, "Ollanta, an old Peruvian Drama in the Quichua Language." The sixth volume of a great work, by Antonio Raimondi, entitled "Demarcacion Politica del Peru," is devoted to ethnology and archæology.

Herr Fritz Müller writes to Mr. Charles Darwin, in a letter published in *Nature*, April 1st, concerning the "Sambaques," or "Casqueros," shell-heaps of the Brazilian coast. They exist in great numbers and of immense size. In some of them skulls were found of unusual thickness.

Europe.—The *Quarterly Review*, No. 283, has an article upon the "Rude Stone Age in the Orkney Islands." Mr. Pengelly read before the British Association the report upon Kent's Cavern during the last year. The excavations, successful in other respects, revealed no human remains. Mr. Thomas Belt contributes to the *Quarterly Journal of Science* for July a paper on the "Geological Age of the Deposits containing Flint Implements at Hoxne, in Sussex, and the Relations that Palæolithic Man bore to the Glacial Period." Mr. A. Whitley made a communication to the Victoria Institute, March 20th, upon the "Flint Knives from Brixham Cave." The author is of the opinion that the older palæolithic knives, etc., are not of human manufacture. The exploration of Cisbury Camp, near Northing, Sussex, is reported in the Proceedings of the Anthropological Institute, November 23, 1875, and Professor Rolleston adds an exhaustive account of the animal remains, including the skeleton of a woman. Before the same society, Canon Rawlinson read a paper, May 3d, upon the "Ethnology of the Cymbri." Further information upon extinct races in Britain may be found in the following references: Professor Rolleston, on the "People of the Long-Barrow Period," Anthropological Institute, January 22d; on the "Tumuli belonging to the Viking Age," British Scandinavian Society, January 18th; on the "Traces of Early Phœnician, Jewish, and Carthaginian Intercourse in the British Isles," by Mr. F. A. Allen, Victoria Institute, February 21st; Aneurio Vaard, upon "Bardism, or the Primitive System of Instruction, Knowledge, and Morals among the Britons," in the *International Review*, March and April; Professor Rolleston, on the "Prehistoric Pig in Britain," Linnæan Society, June 15th. The tendency of English geologists is to refer the palæolithic implements of Brit-

ain to a preglacial, or at least to an interglacial epoch. Mr. Hughes, however, objects to the theory. The subject is discussed in *Nature* for September 21st, October 5th, and November 23d.

At the session of the anthropological section of the French Association, August 23, 1875, M. Valdemar Schmidt discussed the funeral rites of Scandinavia and other parts of the world. The subject of Swedish archæology is made accessible by a work entitled "Bibliographie de l'Archéologie prehistorique de la Suède pendant le XIX[e] Siècle." Stockholm, 1875, 106 pp. 8vo.

The *Revue d'Anthropologie* for February contains the description of the celebrated tumulus of Eshoj, in Denmark, by Professor C. Engelhardt.

Upon Russian archæology and antiquities the following treatises may be consulted: "Étude sur les peuples primitifs de la Russie; Les Meriens," by Count Ouvaroff, in *Matériaux* for May; "The Northern and Northeastern Frontages of the Indo-Europeans in Early Times," Anthropological Institute, H. H. Howorth.

In France the greatest interest is manifested in archæological matters. The three journals noticed in the preceding volumes of the *Record* continue their able editorial staffs, and are really the highest authority upon the French side of disputed questions. We select a few titles from many quite as able and important: "Superposition du Solutréen au Moustérien, à Thorigné," *Matériaux*, No. 4; Études sur quelques monuments megalithiques de la vallée de l'Oise," by Am. de Caix de St. Aymour (ibid.); "Les Tombes lacustres d'Auvernier," Dr. V. Gross (ibid.); "Histoire des mammifères quaternaires ou actuels de nos pays," J. Gaudry, No. 5; "Note sur la découverte d'une station humain de l'époque de la pierre polie près de Belfort," Ch. Grad (ibid.) The "Horse of Solutré" is discussed by E. Trutat, in the Bulletin de la Société d'Histoire Naturelle de Toulouse, 1874–1875. M. Vacher read a paper at the French Association upon the "Ancient places of adoration and upon traces of pagan worship in Auvergne and in Lemousin." In No. 8 of *Comptes-Rendus* there is an article by M. Jaubert upon human remains in the grottoes of different parts of Provence. The Rev. W. C. Lukis, through Johnson & Co., London, publishes a guide to the chambered barrows of South Brittany. The object of this Manual is to enable tourists to make good use of their time in visiting the dolmens of Morbihan, etc.

Drs. Rehman and A. Ecker contribute to the *Archiv für Anthropologie* an article on the quaternary fauna of the valley of the Donau. There is a growing disposition among German archæologists to set aside the division of the prehistoric age into palæolithic, neolithic, bronze, and iron periods; and several discussions have been published, not only in *Archiv*, but also in *Das Ausland* and other German periodicals, looking toward the adoption of two periods only—the stone and the metallic.

The Longmans have published a translation of Merk's work on the excavation at Kesserloch, near Thayngen, Switzerland, which will place this valuable treatise within the reach of English readers. Some doubt is thrown upon these relics by P. Lindenschmidt (*Archiv*, IX., 173). The discovery of sharpened sticks in an interglacial coal-stratum of Switzerland, noticed in the last *Record*, is reviewed by Professor Steenstrup in *Archiv*, under the question whether we have here veritable traces of man, or only the work of beavers. The learned archæologist accompanies his discussion with numerous illustrations, and adduces several instances of sticks in the Danish peat which were thus sharpened. The question what the lacustrians did with their dead has been partly answered by the discovery of one of their tombs on Lake Neuchatel, between Auvernier and Colombier. The slab graves very much resembled those found in the mounds of Tennessee.

In *Matériaux*, No. 12, 1875, is an article by E. Rivière upon the quaternary fauna of the caverns of Baoussé-Roussé, in Italy, called the grottoes of Mentone. Rev. A. H. Sayce reviews in *Academy*, Jan. 29th, Corssen's great work on the Etruscan language. He considers it a failure, "but of such a useful kind that, if Corssen has failed to show that Etruscan is an Italic diet, the question, so far, may be considered as settled, for where Corssen has not succeeded, no one else will." Signor Alessandro Castellani read an instructive paper before the American Association upon Etruscan and Greek art in jewelry, and its revival. Count Gozzadini published at Boulogne, 1875, a beautifully illustrated quarto, entitled "De quelque mors de cheval italiques et de l'épée de Ronzano en bronze." In the Comptes-Rendus de l'Académie des Sciences, etc., de Boulogne, 1875, Signor J. Capellini treats of the Pliocene man in Tuscany. The argument rests, however, upon gashes in the bones of Balænotus and other water animals. To this P. C. de Fondouce replies (*Matériaux*, No. 5) that these gashes are often made in conflicts between individuals of living species. The most important archæological discoveries in Italy are those which have been made in the excavations at Rome.

Mr. Percy Gardner read a paper before the Royal Society of Literature, April 19th, on "Greek River Worship." The subject of glass manufacture among the ancient Greeks is discussed by X. Landerer in *Gaea*, 1876, p. 511. The objects are found mainly in the graves of women, and consist principally of long-necked vases, some of which contain toilet waters. Schliemann, in his researches at Mycenæ, claims to have found the tomb of Agamemnon, containing immense treasures.

Africa.—In the *Revue d'Anthropologie*, No. 3, for this year, is a paper by M. Tissot upon the megalithic monuments and the blonde people of Northern Africa. The article is followed by a learned dis-

cussion by Dr. Paul Broca upon the connection between these monuments, the blonde element in the population, and the early migration of white races into Northern Africa. He opposes the old opinion that the blonde element in the Berber race is derivable from the Huns of Genseric.

The Rede lecture delivered in the Senate-house of the University of Cambridge, by Samuel Birch, was upon the "Monumental History of Egypt." The whole period of Egyptian history is discussed from the earliest monumental remains to the time of Decius, 250 A.D. The subject of prehistoric remains is also discussed in the address. *The Quarterly Journal of Science*, January, 1876, reviews the "Papyrus Ebers," the Hermetic Book of Medicine of the ancient Egyptians, published in Leipsic, in two volumes, by Engelmann. In a paper read before the Victoria Institute, March 6th, Mr. W. R. Cooper discusses the "Horus Myth." Mr. E. Naville, of Geneva, is engaged in collecting the material for an exhaustive edition of the *Rituel Funéraire*, or "The Book of the Dead."

Asia.—In order to have any idea of the immense amount of work done yearly upon the subject of Asiatic archæology, one must study the Transactions and other publications of the Royal Asiatic Society and its East Indian branches, of the Society of Biblical Archæology, of the Société Asiatique, and of the Morgenländische Gesellschaft. Only the most meagre reference can be given here.

The American Palestine Exploration Society seems to be dying out. The Rev. Selah Merrill, however, still holds his ground. The new excavations in the Mesopotamian valley, cut off by the death of Mr. George Smith, will be continued by Mr. Hormuzd Rassam, who has obtained from the Porte a concession of protection for two years. The magnificent discoveries of Di Cesnola, at Kourium, Cyprus, will grace the Metropolitan Museum of Art, New York, where his other Cyprian relics are deposited.

Matériaux, No. 4, 1876, contains an illustrated article upon the erection of megalithic monuments still practiced by some of the mountain tribes of India. The whole series of translations from the "Sacred Books" of the world will be edited by Professor Max Müller. The work will be divided into six sections, under competent specialists, viz., Brahmin, Buddhist, Zoroastrian, Confucian, Lao-tsean, and Mohammedan.

Polynesia.—*Nature* for October 26th contains a lengthy abstract of a paper by Dr. Haast, read at the Philosophic Institute of Canterbury, New Zealand, on "Recent Cavern Researches in New Zealand." Mr. Wm. Brabrook read a communication before the Anthropological Institute, from Mr. W. W. Wood, "On the Tombs in the Island of Rotumah, Fiji." The finding of wooden tablets, containing hiero-

glyphic writing, upon the Eastern Island is announced in the *Geographical Magazine* for May.

II. ETHNOGRAPHY.

North America.—The translation of Dr. Rink's "Tales and Traditions of the Esquimaux," by Dr. Brown, places the investigations of the learned Dane within the reach of English-speaking students. The researches of Abbé Pétitot among the Tchiglit Esquimaux and the Dènè-Dindjié (Tinneh) Indians have been published through the generosity of M. Pinart, as Vols. II. and III. of his "Bibliothèque de Linguistique."

At the American Association at Buffalo the following communications were made upon North American ethnography: "The Iroquois Gens, Phratry, and Tribe," by Hon. L. H. Morgan; "Hybridity and Absorption among the Races of the New World," by Dr. Daniel Wilson; "The Mythology of the North American Indians," by J. W. Powell.

Very instructive manuscripts upon the Indian tribes of the United States have been sent in with the Centennial collections, by J. G. Swan, Rev. M. Eels, Stephen Powers, Rev. Stephen Bowers, Major J. W. Powell, and others. These will appear, from time to time, among the publications of the Smithsonian Institution. In *Das Ausland* for May 29th, Ado Hunnius gives a full statistical report of the Indians of the United States, drawn from official sources.

Middle America.—Professor W. M. Gabb, in a communication already referred to, and published in the Transactions of the American Philosophical Society, June to December, 1875, gives an elaborate account of the Indian tribes and language of Costa Rica. There is scarcely a topic in Herbert Spencer's "Descriptive Sociology" that is not treated in this paper.

"The Anthropology of the Antilles" is the subject of a paper, by M. Cornilhac, in the first volume of the Proceedings of the Société des Americanistes.

South America.—The Smithsonian Institution is in receipt of a manuscript from Lieutenant Harrison describing the natives along the Ucayali River, in Peru.

Wm. Gifford Palgrave, the author of a charming book of travels in Arabia, publishes, through Macmillan & Co., an account of a journey to Dutch Guiana.

Professor Hartt has found time to gather into a small pamphlet, published at Rio Janeiro, a collection of Amazonian tortoise myths.

In the November (1875) Bulletin of the Société de Géographie, M. Maguins gives an account of a visit to Tierra del Fuego. The *Revue Scientifique* describes an expedition to Patagonia by Dr. Carl Berg.

Europe.—Mr. E. W. Brabrook read before the Anthropological Institute, February 22d, a memoir by the Rev. J. Earle upon the "Ethnography of Scotland." The chief feature of the communication was the comparison of the physiognomy and dialects of the Scotch with those of the Norwegians. The same subject was discussed by Hector McLean at the British Association, September 16th. Lady Verny contributes to the *Contemporary Review* for February an essay on "Old Welsh Legends and Poetry."

The communication, by Gustavus Lagneau, read before the Geographical Congress in Paris last year, is published in full in *Revue d'Anthropologie*, No. 4, 1875, with copious bibliographical references.

The Basques are the subject of the following treatises: A paper read before the French Association, 1876, by M. Tubino; an article in *Revue de Linguistique*, October, 1855, by the Rev. Wentworth Webster; a notice in *Bul. de la Soc. de Géog.*, April, by V. Derrécagaix.

No. 3 of *Revue d'Anthropologie* contains a very elaborate paper, by Dr. A. Sasse, upon eighteen skulls which the author procured from an ossuary in Righ, a village in the north of Holland.

In the July number of the *North American Review*, Mr. T. F. Crane treats of the Italian popular tales.

M. Mainof, Secretary of the Ethnological Section of the Russian Geographical Society, is preparing an exhaustive treatise on Russian ethnography. It will appear in parts, each containing the monograph of a section of the people.

The Society of Anthropology of Paris offers a prize to the author of the best memoir on "The Slavic Races," to be accompanied by maps of the countries inhabited by Slavonians. Further contributions to Slavic subjects are: A paper read before the Royal Society of Literature, by Rev. J. Long, upon "Russian Proverbs as illustrating Russian Life and Manners;" a communication upon the Slaves, to the French Association, by M. Hovelacque; an article in the April number of the *Contemporary Review*, by W. S. Ralston, on "Russian Idyls." The October number of the *Geographical Magazine* is devoted largely to the Turkish question. Maps are given, showing the political divisions, the density of population, the distribution of the Mohammedans, and the other nationalities. Dr. Nicolo J. Petrovitsch contributes to *Das Ausland*, June 19th, an article on "Manners and Customs in Servia;" E. Picot, to *Revue d'Anthropologie*, No. 3, 1875, a paper on the Roumanians; and Jos. Jirecek publishes, in Prague, "The History of the Bulgarians."

Africa.—In speaking of the megalithic monuments of Africa, reference was made to the blonde population of Morocco (*Revue d'Anthropologie*, No. 3, 1876). The novel opinions of M. Broca are well worth careful investigation.

Further information of African subjects is to be found in Mr. B.

Walker's paper before the Anthropological Institute on the "Religion, Politics, and Commerce of the Old Calabar Coast;" in M. Hovelacque's article in *Revue d'Anthropologie*, No. 2, on the "Caffres;" in Dr. B. Ferrand's contribution to the third part of the same journal on the "Oulofs of Senegambia;" in Captain Cameron's speeches before the Geographical Society, April 11th, the Anthropological Institute, May 23d, and at the British Association; in Dr. Hartmann's work on the "Nigritians," published in Berlin; in Dr. Mullen's paper in the *Jour. Anth. Inst.*, V., 181, on the "Origin and Progress of the People of Madagascar;" and in No. 4 of Herbert Spencer's "Descriptive Sociology."

Asia.—M. Ujfalvy has been intrusted by the French Minister of Instruction with the preparation of a work on the ethnographical, linguistic, and historical characteristics of the people of Russia and Central Asia. *L'Explorateur*, of May 18th, contains an account of the principal indigenous tribes of Eastern Siberia, from "La Sibérie Orientale, et l'Amérique Russe," of M. Octave Sachat. At a meeting of the Ethnological Section of the Russian Geographical Society, May 13th, M. Venioukoff's recommendation to publish a catalogue of all books and articles relating to Higher Asia and its inhabitants was adopted.

Messrs. Sampson & Low publish a translation of Lieutenant Prejevalsky's "Mongolia," with an introduction by Colonel Henry Yule. The lieutenant will conduct to Central Asia a party, to be gone three years. Ethnological investigations will be a prominent feature of their work.

In the *British Quarterly*, Jan., 1876, is an article on the "Dervishes of Islam," attempting to compare them with the prophets of the Old Testament.

Mr. Alfred Morgan read a paper before the Philosophical and Literary Society of Liverpool, January 10th, on the Khasi Hill Tribes of Northeastern Bengal. In the *Jour. Anth. Inst.* for April, Mr. J. Walhouse describes the Bhutas—devil and ghost worshipers in India. Professor Childers, in *Contemp. Review* for April, has an article entitled "The Whole Duty of the Buddhist Layman."

Maisonneuve & Co., Paris, have published for C. A. Piétrement a pamphlet upon the origin of the Chinese, and the introduction of the horse into China. The *Argonaut*, for July 1st, has an article on the "Amusements of the Chinese."

In the *Jour. Anth. Inst.* for July, Mr. E. B. Tylor discusses the myths of the Japanese.

Oceanica.—The attention of European anthropologists is turned especially to New Guinea. Articles on this subject may be found under the following references: *Archiv für Anth.*, May; *Edinburgh*

Review, July; *Proceedings of the Geographical Society*, June, p. 253, 266; *Jour. Anth. Inst.*, April 25th and June 13th; *Nature*, Dec. 25th, 1875, Jan. 20th, March 9th, June 1st and 8th, 1876; *Academy*, Feb. 19th.

In the *Jour. Anth. Inst.* for April, Mr. James Hector speaks of "Certain Early Forms of Stone Implements in New Zealand." The Rev. Wyatt Gill has, during the year, presented to the Anthropological Institute papers on "The Traditions of the Hervey Islanders," "The Origin of the South Sea Islanders," and "The South Sea Island Mythology." The last-named article is reviewed at length in the *London Quarterly Review* for July. The Rev. S. J. Whitmee, in *Nature*, June 29th, makes some sound observations on the errors which have been made in estimating the population of a country by the census of the sea-coast. Mr. Rankin contributes to the *Jour. Anth. Inst.* for July information upon the South Sea Islanders. Professor Busk has examined skulls from the Hebrides, some of which show signs of artificial compression (*Anth. Inst.*, June 13th). Peschel's "Völkerkunde" has appeared in an English translation, published by D. Appleton & Co., and supplies a felt want of a compendious work on the whole field of anthropology.

III. DEDUCTIVE ANTHROPOLOGY.

1. *Origin and Antiquity of Man.*—The *Quarterly Journal of Science* for October contains an article upon the "Cradle of Civilization." "The Origin and Development of Man," is the title of a critique on Lubbock, Tylor, Lyell, and Huxley, in the *Westminster Review* for January. Mr. A. R. Wallace, in opening the Anthropological Section of the British Association, was pleased to speak in the highest terms of the theory of Mr. Darwin in its application to man, but also to enumerate some of the difficulties which still stand in the way of its total recognition. On the other hand, Dr. Ernst Haeckel takes the broad ground that, from beginning to end, all animated creation is the fruit of "transmission and adaptation." Professor Flower took the occasion of his Hunterian lecture on the "Relation of Extinct to Existing Mammalia" to speak of the geological origin of man. Mr. Frank Clarkson spoke on the "Antiquity of Man" before the Junior Philosophical Society, June 19th. In *Mém. de la Soc. d'Émulation des Côtes-du-Nord*, M. Victor Micault discusses the various time-measures furnished by geology for ascertaining the antiquity of man.

2. *Anatomical and Physiological Investigations.*—The study of cranio-cerebral topography promises to place phrenological researches on a new basis. The subject as treated by Gratiolet, Bischoff, Hunter, Ecker, Heftler, Féré, and others is fully reviewed, with illustrations, by Dr. Paul Broca, in *Revue d'Anthropologie*, No. 2, 1876. The author also gives his own views *in extenso*. The value of the "Orbital Index" is treated in the same journal, No. 4, 1876. Dr. Ecker, in discussing the fluctuating character of the human hand

(*Archiv*, VIII.), calls attention to the length of the fore- and the ring-finger. Dr. Kuhf, in *Revue d'Anthropologie*, No. 3, reviews J. W. Sprengel's "Schädel vom Neanderthal-Typus," and contributes also some notes on prehistoric femurs. Dr. R. Verneau, Paris, is the author of a pamphlet entitled "Le Bassin dans les Sexes et dans les Races" (*Rev. d'Anth.*, No. 2, 1876). Dr. Schmidt, of Essen, contributes to the first quarter of *Archiv* a very elaborate paper upon the true horizontal of the skull. In the same number Dr. A. Ecker discusses the influence of cranial deformation upon the volume, position, and form of the cerebrum and its single parts. Dr. Daniel Wilson read a paper before the American Association on "Brain Weight and Size in Relation to the Relative Capacity of Races." The subject of the anthropology of idiots is discussed in *Archiv für Anth.*, IV., 317. A paper on "Right-handedness" was read before the British Association by Mr. James Shaw. Professor Virchow, in *Abhandl. der Königl. Akad. zu Berlin*, considers some characteristics of the skulls of the lower races of mankind.

3. *External Characters.*—The *Jour. Anth. Institute* reproduces, with plates, the article of Dr. Pruner Bey (*Anth. Rev.*, II., 1864) on "Human Hair as a Race Character." The treatise will well repay a second reading to those who have not had the benefit of the plates.

4. *Comparative Psychology.*—The *Quarterly Journal of Science* publishes an article, by G. J. Romanes, on "Conscience in Animals." The subject of mental progress of animals during the human period was discussed by Mr. James Shaw before the British Association. Articles entitled "Associationism and the Origin of Moral Ideas," and "Evolution in Ethics," are published in *Mind* for July 1, 1876. Professor Barret read before the British Association a paper on "Some Phenomena associated with Abnormal Conditions of the Mind." A warm discussion ensued, in which there was a lack of "philosophic calmness." Professor Paul Mantegazza contributes to *Archivio* a long and studied essay on the "Expression of Grief."

5. *Sex and Race.*—In *Ausland*, for June 19th, Dr. Escherich discusses the numerical relations of the sexes in Prussia, Bavaria, and Würtemberg. In all cases—and the reasons are assigned—there is a preponderance of women over men. Before the London Institution, March 23d, Mr. E. B. Tylor read a communication on the "Races of Mankind and their Civilization."

6. *Environment.* — The influence of geological phenomena upon human migrations was discussed by M. Roujou in a communication to the French Association. Ferd. F. von Andrau treats of the influence of elevation upon human settlements in the *Mittheil. der Anth. Gesellsch.*, in Wien, 1 and 2. M. Paul Bert's treatise on the "Pressure of the Air and Living Beings" is reviewed in *Rev. Sc.*, July 15th, and in *Rev. d'Anth.*, No. 2. In the last-named journal, No. 3, M. A. Morice discusses the "Acclimation of Races of Men and Animals in Lower

Cochin China." *Ausland*, May 29th, reviews Rutimeyer's "Variations of the Animal Kingdom in Switzerland since the Presence of Man there." The Smithsonian Report for 1875 reproduces De Candolle's "Probable Future of the Human Race," from "History of Science and Savans."

IV. CULTURE.

1. *Comprehensive Treatises.*—The *Westminster Review* for July criticises the works of Lubbock and Southall on the early phases of civilization.

2. *Food.*—On this subject we notice Dr. M. J. Schleiden on the "History, Uses, and Symbolism of Salt."

3. *Dwellings and other Constructions.*—Vicomte F. de Langle contributes to the *Bull. Soc. de Géog.*, June, 1876, an essay on "Monuments Megalithiques."

4. *Vessels and Household Utensils.*—In *Ausland*, June 10th, will be found an interesting paper on the early use of pot-stone (*Lapis ollaris*).

5. *Implements of War, the Chase, and Industry.*—Mr. Alfred W. Howitt, writing from Baimsdale, Victoria, to *Nature*, July 20th, minutely describes his experience with the boomerang. Professor George Fischer, of Stuttgart, has published a work on "Nephrite and Jadeite in their Mineralogical Character, and in their Prehistoric and Ethnographical Relation" (*Corr.-Blatt.*, No. 12, 1875). In Nos. 10 and 11 of *Matériaux* for 1875, M. Mortillet contends for the East Indian origin of bronze. Madame Clemence contributes to *Revue d'Anth.* one of her characteristic papers on "Fire among Primitive Peoples." Dr. Büchner writes in *Gaea* (III., 1876) upon the kindred subject, "Die Aeltesten Feuerzeuge."

6. *Domestication.*—Upon the history of the horse attention is called to M. C. A. Pietrement's publications in Paris. M. Hovelacque has published at Paris also a treatise on the "Dog in the Avesta."

7. *Valuing and Measuring.*—A communication to the London Philosophical Society, March 22d, treated of "Coinage in Ancient and Modern Times."

8. *Music.*—Professor Carl Engel's descriptive catalogue of the musical instruments in the South Kensington Museum is prefaced by an essay upon the history of musical apparatus.

9. *Art.*—Upon this subject the following treatises have come before us: "Artes Africanæ," by Dr. George Schweinfurth; "The Artistic Skill of the Africans," *Ausland*, Nov. and Dec., 1875; "Analysis of the Life Form in Art," *Trans. Am. Phil. Soc.*, 1875; "Vorgeschichte der Kunst," Dr. O. Hostinsky, *Ausland*, June 24th, 1876; "L'Art et ses Progrès depuis l'Antiquité," Émile Soldi, Paris, 1876; "A Manual of the Historical Development of Art," G. G. Zerffi, London.

10. *Language.*—The two volumes of Abbé Pétitot, previously re-

ferred to, must be recalled here. M. Coudereau is the author of a very elaborate paper in *Bull. Soc. d'Anth.*, No. 3, 1875, entitled "Essai de Classification des Bruits Articules." Attention is called to Rev. A. H. Sayce's review of Hovelacque, *Nature*, Aug. 10th; "Language and Race," *Jour. Anth. Inst.*, V., II., 212; "The Jelly-fish Theory of Language," *Contemp. Rev.*, April, 1876; and "The Introduction to the Science of Language." Mr. Hyde Clarke contributes to the *Jour. Anth. Inst.* interesting papers on prehistoric language (*Nature*, May 25th; *Athenæum*, Aug. 5th); The Fifth Annual Address of the Rev. Richard Morris before the London Philological Society, May 19th, is an admirable summary in this special field. The author had the aid of Dr. J. Muir and Professor Eggeling on Sanskrit; of Ujfalvy on the Ugro-Finnish; of Dr. Neubauer on Talmudical and Rabbinical Literature; of the Rev. A. H. Sayce on the Etruscan; of R. N. Cust on the Non-Aryan Languages of India; of Dr. J. H. Trumbull on N. A. Indian Languages; of Edouard Naville on the Egyptian; and of Dr. Kölbing on Teutonic Languages.

11. *The Family.*—"La Famiglia e la Societa negli Animali e nell' uomo" is the name of an article in *Rivista Anth. ed Eth.*

12. *Social Life and Customs.*—The following treatises are to be noticed: "La Trépanation Préhistorique," J. de Baye, Paris; "Cremation," *Dublin Review*, No. 157; "Les Rites Funéraires," etc., M. Royer, *Rev. d'Anth.*, No. 3; "The Last Act," Wm. Tegg, London; "Sur l'usage des Bâtons de Main," F. Chabas, 1876; "Wege und Ziele der Oekonomie," Dr. Weiss, *Ausland*, June 5th, 1876.

13. *Religion.*—Our space allows us merely to call attention to the following: M. Mortillet's address before the French Association on the "Origin of Superstitions;" Tiele's "Law of Religious Development," *Rev. Politique*, Aug. 12th; "The Chief Non-Christian Systems of Religion," by the Society for Promoting Christian Knowledge; Miss Buckland's paper on "Rhabdomancy and Belomancy," *Jour. Anth. Inst.*, April; Dr. Wakes Smart on "The Ancient Worship of Strings," Brit. Arch. Assoc.; Dr. Collineau on "Religious Mania," *Bull. Soc. d'Anth.*, No. 3, 1875; "Lucky Days," etc., *Mittheil. Anth. Ges. in Wien;* "Serpent and Siva Worship in America," Hyde Clarke, *Anth. Inst.*, June 27th; "Demonolatry," etc., *Contemp. Review*, Feb.; W. P. Distant on the "Term Religion in Anthropology."

V. INSTRUMENTALITIES OF RESEARCH.

Apparatus of Observation.—"Instructions Craniologiques et Craniométriques," *Soc. d'Anth.*, Paris; "La Cranioscope," M. Lenhossek, *Mém. Acad. Soc.*, Buda-Pesth; "Zur Frage nach der Methode der Schädelmessung," *Corr.-Blatt.*, I., 1876.

Terminology.—Ecker, in *Archiv*, May, on "Prehistoric Terminology;" a paper by O. T. Mason, American Association, on the "Scope of Anthropology and the Classification of its Materials." Discussions

on the terms "Anthropology," "Ethnology," and "Ethnography" in *Bull. Soc. d'Anth.*, Nos. 2 and 3.

Societies and Transactions.—The *Annual Record* for 1875 contains a full account of these. The American Anthropological Society founded at Philadelphia, Sept. 9th, is the only addition made to the list of societies, and *Beiträge zur Anthropologie und Urgeschichte Bayerns* to the list of journals. The next Congress of Americanists will meet at Luxemburg, Sept. 10th–13th, 1877. The annual meeting of the Indiana State Archæological Association convened at Indianopolis, Oct. 17th. The third session of the International Congress of Orientalists was opened at St. Petersburg, Sept. 9th. The British Association meet in Glasgow, Sept. 6th; the French Association at Clermont-Ferrand, Aug. 18th–25th; the Eighth Congress of Anthropology, etc., met at Buda-Pesth, Sept. 4th. The annual meeting of the German Anthropological Society was held in Jena, Aug. 9th–11th. The American Association was held in Buffalo, Aug. 23d–30th, Hon. Lewis H. Morgan being chairman of the Anthropological Subsection. The next meeting will be held in Nashville, Tenn., and Dr. Daniel Wilson will preside over the Anthropological Subsection.

In conclusion, we refer our readers to Gerland's "Atlas der Ethnographie," Leipzig, Brockhaus, 1876; "Le Dictionnaire Archéologique de la Gaule," A–G, Paris; "Verzeichniss der Anthropologie schen Literatur," H. Schaaffhausen und A. Ecker, Berlin; "Nouvelle Géographie Universelle, la Terre et les Hommes," E. Reclus, liv. 1–66; "Bibliographie de l'Archéologie Préhistorique de la Suède pendant le XIX[e] Siècle," Montelius, Stockholm, 1875; "Crania Ethnica," Quatrefages & Hamy, liv. 1–4, Paris, 1875; "Thesaurus Craniorum," J. Barnard Davis, London.

GENERAL ZOOLOGY.

I.—By Dr. A. S. PACKARD, Jr.

A review of the work accomplished by zoologists during the year 1876 shows no diminution in the interest felt in this subject, either abroad or at home.

The British Arctic Expedition has returned with zoological collections of great value, while the arctic expeditions of the Swedish government, under Nordenskjöld, and the Norwegian deep-sea expedition to Iceland, as well as the researches in the Rocky Mountains carried on in connection with Professor Hayden's United States Geological and Geographical Survey of the Territories, have been productive of good results.

A very thorough survey of the Baltic is in progress, under the direction of the German minister of agriculture. We have received the zoological portions of the reports, which are of much interest. They are in the same direction as the reports of our United States Fish Commissioner, which are confined by government, as yet, chiefly to fisheries and fish-food.

A summer school of Biology, under the auspices of the Peabody Academy of Science, was held at Salem, Massachusetts, with such success that it is hoped that this institution, with its advantages for the study of marine life, may lead to the establishment at this point of a zoological station for naturalists as well as science-teachers. In Germany they are agitating the establishment of a new zoological station at Kiel and Heligoland, while others have been started at Trieste and Sebastopol, and there is a plan to erect a Russian station on the White Sea. The small station at Roscoff, on the coast of Normandy, France, established by Professor Lacaze-Duthiers, is still useful; while Dr. Anton Dohrn's magnificent establishment at Naples, the parent of all these enterprises, has afforded special facilities to some of the leading observers of Europe; and, while it has been a costly undertaking, Dr. Dohrn writes that "there is well-founded hope that the Naples station will soon be free from such embarrassments as are the consequences of insufficient means," since the German government will probably grant five or six thousand dollars to its maintenance.

Articles on progress in American zoology during the past century have been published in *Harper's Magazine*, by Professor T. Gill, and in the *American Naturalist*, by the writer.

Professor E. S. Morse's discourse, as President of Section B, Geology and Biology, of the American Association for the Advancement of

Science, was on the contributions made to the theory of Evolution by American naturalists.

In his late address before the section of Biology of the British Association, Mr. Alfred R. Wallace remarked on the peculiar relations of plants and insects as exhibited on islands. As many plants can only be fertilized by insects, the absence of the latter would, of course, tend to prevent the continued existence of plants. This affords a clew to much of the peculiarity of the floras of oceanic islands. Albatrosses, gulls, puffins, tropic birds, and many others nest inland, often amid dense vegetation; and it is thought that they often carry seeds, attached to their feathers, from island to island, for great distances. In the tropics they often nest on the mountains, far inland, and may thus aid in the distribution even of mountain plants. Insects, on the other hand, are mostly conveyed by currents of air, especially by violent gales; and it may thus often happen that totally unrelated plants and insects may be brought together, in which case the former must often perish for want of suitable insects to fertilize them. Much of the poverty and exceptional distribution of the plants of the Polynesian Islands is probably due to the great scarcity of flower-frequenting insects. Lepidoptera and Hymenoptera are exceedingly scarce in the eastern islands of the Pacific, and it is almost certain that many plants which require these insects for their fertilization have been thereby prevented from establishing themselves. In the western islands, such as the Fijis, several species of butterflies occur in tolerable abundance, and no doubt some flower-haunting Hymenoptera accompany them; and in these islands the flora appears to be much more varied, and especially to be characterized by a much greater variety of showy flowers. Mr. Moseley has suggested that a flower which had acquired a brilliant color to attract insects might, on transference to another country, and becoming so modified as to be capable of self-fertilization, retain the colored petals for an indefinite period. Such is probably the explanation of the pelargonium of Kerguelen's Land, which forms masses of bright color near the shore during the flowering season, while most of the other plants of the island have colorless flowers, in accordance with the almost total absence of winged insects. "The researches of Dr. Herman Müller have shown us by what minute modification of structure or of function many flowers are adapted for partial insect- and self-fertilization in varying degrees; so that we have no difficulty in understanding how, as the insects diminished and finally disappeared, self-fertilization may have become the rule, while the large and showy corollas remain to tell us plainly of a once different state of things."

A new work, by Mr. Alfred R. Wallace, on the geographical distribution of animals, bids fair to prove of much interest to naturalists, though it will afford food for discussion.

The essays by Mr. J. A. Allen on the geographical distribution of certain birds and mammals, notably the bison, and the essay by the writer, on the distribution of the Geometrid moths, in his monograph of that family, are fresh contributions to zoögeography.

In a paper on the origin of the deep-water fauna of the Lake of Geneva, M. Forel thinks the entire fauna of the Swiss lakes is descended from forms which have migrated up the rivers since the melting of the glaciers, and have afterward been differentiated.

Among recent contributions to the general subject of the embryology of animals are two by Professor E. Van Beneden, of Liege. One is on the maturation and fecundation of the egg and earlier embryonic phases of the mammals, from researches made on the rabbit, and is an extension of Bischoff's famous work on the embryology of the rabbit. A second paper, on the history of the germinative vesicle, is based on studies made on the common star-fish of the European coast (*Asteracanthion rubens*). A paper of a very different sort is a fierce attack on the "gastræa" theory, by M. Moquin-Tandon, in the *Annales des Sciences Naturelles*. He concludes that it does not rest on any fundamental fact, and can not serve as a base of a phylogenetic classification. The theory had previously been attacked in the *American Naturalist* for February by Mr. A. Agassiz. On the other hand, in the April number of the same magazine, Professor Cope, in an article entitled "Progress of Discovery of the Laws of Evolution," welcomes Haeckel's gastræa theory, which we have previously explained. Cope says that this theory has "added the keystone to the doctrine of evolution in his gastræa theory."

Several embryological papers of value have been published by Balfour, who also fully indorses the gastræa theory of Haeckel.

Some four years ago the Rev. W. H. Dalliger and Dr. Drysdale began to publish a series of papers, which have attracted much notice, on the life-history of monads. The last is now published. The authors remark that simple conditions of season and temperature may account for their successive appearance in the fluid, without supposing that one form was developed out of another. "On the contrary, the life-cycle of a monad is as rigidly circumscribed within defined limits as that of a mollusk or a bird." In no instance was the continuance of the species maintained without the introduction of a sexual process, a blending of what were shown in the sequel to be genetic elements. The experiments as to the effect of heat on the monads and their spores uniformly established an important fact, viz., that the spores resist heat much better than the adults. A temperature of 150° Fahr. was always found to destroy utterly all the adult forms, while the spores resulting from sexual generation have a power of resistance to heat which is greater than this in the proportion of eleven to six on the average. "This appears to us," they say, "to be the very essence of the question of biogenesis *versus*

abiogenesis. In some, at least, of the septic organisms spores are demonstrably produced, and these spores can resist a temperature nearly double that of adults on the average; that which some can resist is 88° Fahr. above the boiling-point of water." This, adds the *Quarterly Journal of Microscopical Science*, is in harmony with the experiments of Roberts, and the later ones of Huizinga.

In a little book entitled "Half-Hours with Insects," the writer cites a number of unpublished facts regarding mimicry in insects, and inclines to the belief that the resemblance in pattern and color between insects belonging to different groups is probably due to causes more fundamental than natural and sexual selection, and reaching possibly farther back in geological time than the present period. The majority of mimickers of other insects belong to groups lower in the organic scale than the insects they mimic, and may have been preserved by virtue of their resemblance to butterflies originating at a later date.

In his address at the last meeting of the British Association for the Advancement of Science, Professor Alfred Newton adverts to the subject of the extinction of animals by natural and artificial or human causes. "It is notorious," he says, "that various members of the orders *Sirenia*, *Cetacea*, and *Pinnipedia* have recently dwindled in numbers, or altogether vanished from the earth. The manatee and dugong have been recklessly killed off from hundreds of localities where but a century or so since they abounded, and with them the stores of valuable oil that they furnished have been lost. That very remarkable Sirenian, the huge *Rhytina gigas*, has become utterly extinct. The greed of whalers is believed to have had the same effect on a cetacean (the *Balæna biscayensis*) which was once the cause of a flourishing industry on the coasts of France and Spain. The same greed has almost exterminated the right-whale of the northern seas, and is fast accomplishing the same end in the case of seals all over the world." He also speaks of the alarming decrease of fish and edible mollusks.

Perhaps the most remarkable biological work of the year is Professor August Weismann's treatise on the "Final Causes of Transmutation," forming the second part of his studies on the "Theory of Descent." The first part of the work, entitled "Seasonal Dimorphism," was noticed on p. cxciv. of the *Annual Record* for 1875. The present work is divided into three divisions, of which the first presents an array of facts on the origin of the markings of caterpillars. The author describes the nature and morphology of the markings of larvæ of the family *Sphingidæ*, their biological value, and phyletic development, concluding that the oldest sphingid caterpillars were without markings, that the oldest style of markings were longitudinal lines, the later ones oblique streaks, and the last to be developed were the spots. This part of the subject is illustrated by five colored

plates. In the third section the transformation of the Mexican axolotl into an *Amblystoma* is discussed at considerable length and with characteristic thoroughness. Professor Weismann believes that the *Siredon* or axolotl was originally derived from a land salamander (*Amblystoma*), but has reverted to an axolotl or larval form through the change of the climate of Mexico from a damp to an exceedingly dry one, obliging these animals, which as larvæ lived in ponds, and as adults formerly lived under trees and stones or in damp places, to revert to the original larval siredon form and remain permanently amphibious. In the fourth division, "On the Mechanical Conception of Nature," the author maintains that development is mechanical, and that we must reject the idea of a special life-force. Still he as strongly believes in teleology, and maintains the thesis that evolutional views do not lead to materialism.

II.—By Dr. THEODORE GILL.

One of the most important works of the year is a treatise, in two volumes, "On the Geographical Distribution of Animals, with a Study of the Relations of Living and Extinct Faunas, as elucidating the past Changes of the Earth's Surface," by Alfred Russell Wallace, author of the "Malay Archipelago," and a co-discoverer with Darwin of the law of Natural Selection. This author has long been favorably known as a geographical zoologist, and first defined the boundaries between the Australian and Indian realms.

He divides his subject into several parts. In the first part he discusses the principles and general phenomena of the distribution under chapters, (1) introductory; (2) the means of dispersal and the migrations of animals; (3) distribution as affected by the conditions and changes of the earth's surface; (4) on zoological regions; and (5) classification as affecting the study of geographical distribution. In the second part he discourses on the distribution of extinct animals; and in the third part he enters into a consideration of "zoological geography: a review of the chief forms of life in the several regions and sub-regions, with the indications they afford of geographical mutations." In a fourth and final part he considers the geographical zoology in a systematic sketch under the different families of animals in their geographical relations.

The older naturalists, says Mr. Wallace, "had a sort of vague notion that certain forms were peculiar to hot climates, and that certain others were only found in cold countries; but that was about all they knew or cared to know. Of the necessity of precise knowledge on the subject of locality they were absolutely incredulous. To the modern naturalist, on the other hand, the native country, or 'habitat,' as it is technically termed, of an animal or a group of animals is a matter of the first importance, and, as regards the general history of life upon the globe, may be considered to be one of its es-

sential characters. The structure, affinities, and habits of a species now form only part of its natural history. We require, also, to know its exact range at the present day and in prehistoric times, and to have some knowledge of its geological age, the place of its earliest appearance on the globe, and of the various extinct forms most nearly allied to it. To those who accept the theory of development as worked out by Mr. Darwin, and the views as to the general permanence and immense antiquity of the great continents and oceans so ably developed by Sir Charles Lyell, it ceases to be a matter of surprise that the tropics of Africa, Asia, and America should differ in their productions; but rather that they should have any thing in common. Their similarity, not their diversity, is the fact that most frequently puzzles us."

The author has confined his investigations to the several classes of vertebrates, a few prominent families of insects, and the branch of mollusks. An analysis of his work, however, reveals that he was chiefly influenced by the phenomena of the distribution of birds, with which class he was evidently most familiar; with the other classes he was apparently but imperfectly conversant. In one paragraph (vol. i., p. 56) he discusses the question of "which class of animals is of most importance in determining zoological regions." He arrives at the conclusion that in all essential points "the mammalia are pre-eminent; and they possess the additional advantage of being the most highly developed class of organized beings, and that to which we ourselves belong." Many naturalists, however, will be disposed to dissent from him in this view; and, taking the author's own standard of what best qualifies a group for the expression of laws of geographical distribution, we are constrained to believe that the inhabitants of fresh-water basins, and especially the fishes, are pre-eminently the most truth-telling exponents of the relations of the several regions of the globe to each other now and in the past. It is evident, however, that, in spite of the expression of opinion of the author, he has been influenced by the facts of geographical distribution of mammals much less than by those of birds; and to this bias is undoubtedly attributable the sequence and combinations of the "regions" which he has adopted. These regions are six in number, and for them he adopts the names of his compatriot, Mr. Sclater. The regions are divided by a procrustean system each into exactly four sub-regions. They are as follows:

I. The Palæarctic Region, with the sub-regions (1) North America, (2) Mediterranean (or S. Eu.), (3) Siberia, and (4) Manchuria (or Japan).

II. The Ethiopian Region, with the sub-regions (1) East Africa, (2) West Africa, (3) South Africa, and (4) Madagascar.

III. The Oriental Region, comprising the sub-regions of (1) Hindostan (or Central Ind.), (2) Ceylon, (3) Indo-China (or Himalayas), and (4) Indo-Malaya.

IV. The Australian Region, embracing the sub-regions of (1) Austro-Malaya, (2) Australia, (3) Polynesia, and (4) New Zealand.

V. The Neotropical Region, including the sub-regions of (1) Chili (or S. Temp. Am.), (2) Brazil, (3) Mexico (or Trop. N. Am.), and (4) Antilles.

VI. The Nearctic Region, with the sub-regions (1) California, (2) Rocky Mountains, (3) Alleghanies (or Eastern U. S.), and (4) Canada.

This is not the place to further comment upon Mr. Wallace's views. Suffice it to say that, although there are many errors, the work is one of sterling value; and will doubtless give a decided impetus to the philosophical consideration of the phenomena of the distribution of animal life over the earth, and its causes.

INVERTEBRATE ZOOLOGY.

BY DR. A. S. PACKARD, JR.

The Rhizopods of this country are still undergoing examination by Professor Leidy. In speaking of the Difflugian Rhizopods, Dr. Wallich expresses the opinion that the whole are referable to a single specific type, while Dr. Carpenter is quoted as saying that "whether it will ever be practicable to arrange the multitudinous forms of this group in natural assemblages, whose boundaries shall be capable of strict limitation, is to us by no means certain." Dr. Leidy adds that it would seem that the existing rhizopods, in respect to classification, may be viewed as an epitome of all organic forms in all times; for, if all these could be known, it would be found that there were no absolute limits defining species, or any other of the usual divisions in classification. Many of the freshwater forms of this country are identical with those of Europe. The *Amœba*, it will be remembered, is the simplest form of rhizopod, while the shelled forms are called Foraminifera, and Eozoon is supposed to be one of these.

An account by Hertwig of a new acinetan infusorian (*Podophrya gemmipara*) appears in the new German *Journal of Anatomy and Embryology*, edited by Gegenbaur. After a review of the structure of the Acinetæ generally, the author speculates on the origin of these interesting forms, and believes that the original ancestral form from which the Acinetæ and infusoria sprang was a one-celled organism covered with cilia.

Dr. Bütschli describes the production in *Podophrya* of ciliated young, somewhat resembling those of other normal *Infusoria ciliata*.

The sun-animalcule (*Actinophrys Sol*) has been observed by Mr. Fullagar to pass through the following changes. After encysting, having previously drawn in its spine-like "pseudopodia," it divides into two equal-sized globes, which, after remaining separate for a few hours, unite again, forming a smaller sphere than the original one. It now moves about by thrusting out two or three pseudopodia, and then resting for a while. At times also a cloudy matter exudes from them, out of which Amœba-like bodies proceed, resembling the forms of different so-called species of Amœba. The author asks, "What connection have they with *Actinophrys Sol*, being found so closely mixed up with them?" He does not answer the question; but, judging from the mode of development of certain

moners described by Haeckel, the minute Amœbæ may prove to be young Actinophrys. Should these observations be confirmed, Mr. Fullagar has, perhaps, discovered the mode of reproduction by encysting and the formation of motile Amœba-like young, which has not yet been observed in this animalcule. He also describes the formation of young Actinophrys by self-division. Two modes of reproduction, then, seem to be established—one by encysting and the other by self-division. Graef had noticed previously the multiplication of the sun-animalcule by self-division, and Schneider had also seen them encyst themselves in the autumn, and the small Actinophrys come out of the cyst in the spring.

In special groups of animals, beginning with the lowest, we have fresh information regarding the foraminifera, or lower shelled rhizopods. One of these animals, the *Globigerina*, has at length been seen by the *Challenger* party with its "pseudopodia," or thread-like extensions of the body, spreading out in the water. Professor Wyville Thompson states that if a specimen be immediately transferred from the tow-net to some fresh sea-water, and be examined with a high power, the "sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell, and spread out until they form a gelatinous fringe or border around the shell, filling up the spaces among the roots of the spines, and rising up a little way along their length." It will be remembered that the dead shells of these foraminifers accumulate in such immense quantities as to form modern chalk at great ocean depths.

The sponges are now recognized as a distinct sub-kingdom of animals by Huxley, Macallister, and Hyatt. Their embryology has been restudied with great thoroughness by Barrois, a French observer, who, with F. E. Schulze, acknowledges the presence of three germlayers, and confirms the embryological observations of Haeckel.

Professor Hyatt's "Revision of the North American Poriferæ" is the first installment of a series of papers on our native sponges, comprising considerable work done under the auspices of the United States Fish Commission, as well as on specimens from the different museums of the country. It is accompanied by a plate drawn on stone, and contains remarks on foreign species.

While the sponges are thus taken from the Protozoa on the one hand, and the Polyps on the other, and regarded as representatives of a distinct sub-kingdom, Professor E. Van Beneden, in his elaborate "Recherches sur les Dicyemides, survivants actuels d'un Embranchement des Mesozoaires," proposes a new sub-kingdom of animals. In 1830 Krohn observed the presence in the liquid bathing the spongy bodies (perhaps renal organs) of different species of cephalopods certain filiform bodies, covered with vibratile cilia, and resembling infusoria or ciliated worms. They were called *Dicyema* by Kölliker, who, with others, considered them as intestinal worms.

Van Beneden claims that they have no general body-cavity. The body is formed (1) of a large axial, cylindrical, or fusiform cell, which extends from the anterior extremity of the body, enlarged into a head, to the caudal extremity; (2) of a single row of flat cells, forming around the axial cell a sort of simple pavement epithelium. All these cells are placed in juxtaposition like the constituent elements of a vegetable tissue. There is no trace of a homogeneous layer, of connective tissue, of muscular fibre, of nervous elements, nor of intercellular substance. There is only between the cells a homogeneous (*unissante*) substance, as between epithelial cells. The axial cell is regarded as homologous with the endoderm of the higher animals (*Metazoa*). He designates as the ectodermic layer the cells surrounding the large single axial cell. There exists no trace of a middle layer of cells. We discover no differentiated apparatus; all the animal and vegetative functions are accomplished by the activity of the ectodermic cells and of the axial cell. On account of these characteristics, Van Beneden regards these organisms as forming the type of a new branch of the animal kingdom, which he designates *Mesozoa.*

Each species of *Dicyema* comprises two sorts of individuals differing externally, one (the *Nematogene*) producing vermiform embryos, the other (Rhombogene) infusoriform young. The Nematogenes produce germs which undergo total segmentation—assume a *gastrula* condition. After the closure of the blastopore the body elongates, the worm-like form of the adult is finally attained, and they pass through the body-walls of the parent.

The germs of the Rhombogenes arise endogenously in special cells lodged in the axial cell, and called "germigenes." The germ-cells undergo segmentation, and then form small spheres which become infusoriform embryos. The worm-like young is destined to be developed, and live in the cephalopod where it has been born, while the infusorian-like young probably performs the office of disseminating the species; it transmits the parasite of one cephalopod to another.

This work is also an important contribution to histology, particularly to the subject of cell-divisions. Says Van Beneden: "The recent researches of Auerbach, of Bütschli, of Strasburger, of Hertwich, and those that I have published, have established the fact that the division of a cellule—that is to say, the multiplication of the cellular individuality is the resultant of a long series of complex phenomena, accomplished in a determinate order, and having their seat as much in the nucleus as in the substance of the cell."

Finally, Van Beneden places in his branch of *Mesozoa* the hypothetical *Gastraades*, which term he applies to (*gastrula*-like) organisms formed of two kinds of cellules, some ectodermic, others endodermic, in which the endoderm is formed by invagination. He calls *Planu-*

lades those hypothetical mesozoa which are formed from a many-celled sphere, constituted like a *Magosphæra* (Haeckel), and in which the two cellular layers are developed by delamination. He therefore divides the animal kingdom into three primary groups—*i. e.*, the *Protozoa*, the *Mesozoa*, and the *Metazoa*.

It appears that a species of *Campanularia*, a hydroid medusa, has been found in Greenland by the *Valorous* on its return from Disco, which is said to be identical with one found by Mr. Eaton, of the British Transit of Venus Expedition, at Kerguelen Island; while the deep waters of Davis Strait afford a shell which was long since found fossil in the newer tertiary beds of Sicily, and was supposed to be extinct.

The animal of the coral, Millepora, was by the late Professor Agassiz regarded as a hydroid polyp, or jelly-fish, rather than a true coral polyp. Now, however, it has been shown by Mr. Moseley, of the *Challenger* expedition, who studied the Millepora at Bermuda, that the animal is probably a true polyp. He says that the examination of the Millepora is beset with serious difficulties; but he observed that there are large and small polyps, that both kinds have tentacles, and appear to be four in number and to be compound. Before this, however, General Nelson, of Bermuda, had made drawings of the animal of Millepora, upon which the following comments have been made by Professor Duncan, of London, in *Nature:* "It is a satisfaction for me to be able to state that General Nelson's drawings prove that Agassiz saw a part of the polyp, and that Mr. Moseley's beautiful delineations, far in advance of all, testify to the correctness of my fellow-worker. I do not credit the hydroid nature of the polyp now, any more than I did when writing the reports on the British fossil corals, and I believe Millepora to be an Actinozoan."

The effect of certain poisons on *Medusæ* is described by Mr. G. J. Romanes in the Proceedings of the Royal Society. He states that strychnia exerts a very marked influence upon them. "Of the species I have met with, *Cyanea capillata* is the most suitable for showing the effects of this poison, from the fact that in water kept at a constant temperature the normal pulsations of this animal are as regular as those of a heart. Shortly after a solution of strychnia has been added to the water in which a specimen of *C. capillata* is contained, unmistakable signs of irregularity in the pulsations of the animal supervene. This irregularity then increases more and more, until at last it grows into well-marked convulsions. The convulsions manifest themselves in the form of extreme deviations from the rhythmical character of the normal contractions, amounting, in fact, to nothing less than tonic spasms. It is further of importance to remark that the convulsions are very plainly of a paroxysmal nature, prolonged periods of uninterrupted convulsions being every now and then relieved by shorter periods of repose, during which the

medusa remains perfectly motionless in a fully expanded form. *C. capillata* will live for many hours when under the influence of strychnia, but eventually death supervenes. The animal dies in full diastole."

The Bulletin of the Museum of Comparative Zoology contains notes and descriptions of some recent corals found by Mr. A. Agassiz at a height of 2900 to 3000 feet above the level of the sea, at a distance in a straight line from the Pacific Ocean of twenty miles.

That sea-urchins are sometimes viviparous, not passing through a metamorphosis, was first shown by Philippi (1845) in a South American species of *Hemiaster*. He found young sea-urchins in a sunken ambulacral area of the adult, and regarded them as the young of the Hemiaster. Lately it has been discovered by Grube that the young of *Anochanus*, a genus of sea-urchins occurring in the East Indies, live under similar conditions. During the present year Mr. A. Agassiz has examined some Hemiasters brought home by Dr. J. H. Kidder, the naturalist of the Transit of Venus Expedition, from Kerguelen Island, and finds that they are viviparous, the eggs (or the imperfectly developed pluteus or larva) probably escaping from the genital openings, readily finding their way into the artificial cavity formed by the spines which conceal the presence of the sunken areas, which serve as brood cavities.

M. L. Fredericq has studied the anatomy and histology of the nervous and muscular system of Echini. He finds, as stated in a communication made to the French Academy, that the pentagonal nervous ring which surrounds the œsophagus, and the five ambulacral cords which go from it, are contained within a special system of canals which can be readily observed. The famous eye-like spots he claims only exist in the imagination of those who invented them. The nervous ring and the large trunks which are sent off from them are identical in structure, and should be considered as nervous centres. The muscles are formed of very fine fibres, which are cylindrical, entirely smooth and homogeneous throughout, with no enveloping membrane. M. E. Perrier has also published (*Archives de Zoologie*) researches on the circulatory system of Echini; while, in the *Archiv für microskopische Anatomie*, Professor Alexander Goette gives the developmental history of *Comatula Mediterraniensis;* while Dr. R. Teuscher describes the minute anatomy of Comatula and the sand-stars (Ophiuridæ). A new *Peripatus* has been found in New Zealand by Captain F. W. Hutton, who calls it *Peripatus Novæ-Zealandiæ*. This animal is a worm with tracheal or respiratory tubes in the young stages, and is thus a connecting link between the insects and worms.

During the spring of the year humble-bees are in Europe infested by great numbers of a minute worm, called by Dufour *Sphærularia Bombi*. Says Mr. Cole, in the *Journal* of the Quickett Microscop-

ical Club: "The Sphærulariæ are not found, as is commonly the case with the mature entozoa, in the interior of the alimentary canal. They lie perfectly free among the viscera in the upper portion of the abdominal cavity, and are bathed on all sides with the nutritive fluids of the bee. They are generally more or less coiled up, and are absolutely without motion. They have thus far only been found in female bees. The mature female Sphærulariæ are about an inch in length; while the males, as they are regarded by Lubbock and others, are very minute, being about one twentieth of an inch long, or about ten thousand times smaller than the females. They seem to be almost invariably attached near the head of the females. A German observer (Schneider) believes the so-called female to be merely the enlarged oviduct of the small worm, which he regards as the true female.

Dr. Cobbold continues, in the Proceedings of the Zoological Society, his illustrated notes on the *Entozoa*.

The unarmed Gephyrean worms, such as the various species of Sipunculus, have been studied in part anatomically by H. Théel; while MM. Marion and Bobretzky have investigated the worms of the Mediterranean Sea.

One of the most important discoveries in zoology of the past year is the curious fact regarding the development of the Salpa of our coast. Mr. W. K. Brooks finds that in this animal, which occurs on the southern shores of New England, and swims either solitary or in chain-like aggregations of individuals, the solitary individuals are females, while the individuals which make up the chain are males. The solitary female produces a chain of males by budding, and discharges an egg into each before birth. These eggs are impregnated while the animals composing the chain are small and sexually immature, and develop into females, which give rise to other males by budding. After the embryo has been discharged from the body of the male, the latter grows up, becomes sexually mature, and discharges its seminal fluid into the water, by means of which it is carried to the eggs within the bodies of younger chains. This is quite a different mode of growth from that suggested over a century ago by the poet Chamisso.

A singular animal has been discovered, at the depth of fifty fathoms, by Mr. Tycho Tullberg, among the islands and fiords of the western coast of Sweden. After giving a lengthy review of its external appearance and anatomy, the author hesitates at present to offer any opinion as to the systematic position of the animal, though he ventures the remark that the type of mollusca and that of vermes seem both to claim *Neomenia* as a distant relation, the latter, perhaps, with more right than the former. *Neomenia*, however, presents considerable deviations from both, in the absence of a radula, in the structure of the alimentary canal and of the nervous system, as also in other respects, as the form of the body and the spines on the skin.

Excellent plates accompany the article, which is written in the English language.

The embryology of the mollusks has been studied by Fol, Ray-Lankester, Rabl, Jhering, and Bobretzky; while Professor Leydig has published, in Troschel's *Archiv*, an elaborate account of the shells and tegumentary coverings of the gastropod mollusks. Rabl's paper on the development of *Unio*, in the *Jenaische Zeitschrift*, is especially noteworthy.

An interesting article on the habits of the singular fluviatile shell *Io* is contributed to the *American Naturalist* by Dr. Lewis. They live in the rivers of Tennessee, and are so solid and of such bright colors that they might be mistaken for sea-shells. It seems that they were known to the Indians before the advent of European races, as they have been found in their graves.

The last annual report of Professor Hayden's United States Geological Survey contains an excellent account of the snails collected in Colorado by Mr. E. Ingersoll. Six new species were collected, and much interesting information given regarding the vertical distribution of the species found.

Besides Rabl's later paper, a very fully illustrated memoir on the development of the fresh-water mussels (*Unio* and *Anodonta*) of Europe, by W. Flemming, had been previously published in the Proceedings of the Royal Academy of Science of Vienna for 1875. The papers will interest American students, since these mussels so abound in our rivers. Similar but less extended researches have been carried on in this country by Dr. W. K. Brooks, but we believe they are as yet unpublished.

The great work of Mr. F. B. Meek on the "Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri" is illustrated by forty-five plates, and treats principally of fossil mollusks. It will be indispensable to the geologist of the far West, as the different divisions of the cretaceous and tertiary ages were originally established by the invertebrate remains therein described, and it therefore forms the basis of our knowledge of the two most important formations in the West.

A large volume on the fauna of the land and fresh-water shells of Northeastern Africa, by Carl F. Jickeli, has recently appeared. A number of forms, reaching as far south as Zanzibar, are included. The work is accompanied by eleven excellent plates. Though bearing date 1874, it has only recently been received in this country.

Dr. W. K. Brooks, in a paper entitled "Affinity of the Mollusca and Molluscoida" (polyzoa and brachiopods), suggests that the tunicates are not mollusks, and that the polyzoa and brachiopods are derived from the worms. He also, as others have suggested, thinks that the mollusks are also derived from the worms. He believes that the polyzoa originated from a type like the brachiopods. Thus

it would seem, he says, "not only that the mollusca and molluscoida (polyzoa and brachiopods) are related, but that they are connected so closely that the advisability of such a division is very doubtful." He does not believe that the lamellibranchs are typical mollusks, but that the gasteropods should be considered so, and that the lamellibranchs are derivations from them.

Dr. Rabl gives an account of the embryological development of certain pond snails belonging to the genera *Lymnæus*, *Physa*, *Planorbis*, and *Ancylus*. These investigations are of interest from the clearness with which the "gastrula" stage is presented in *Lymnæus ovatus*, the same phase ("invaginate gastrula") being much more obscurely marked in *Lymnæus stagnalis*, as observed by Ray-Lankester. It appears that all the fresh-water pulmonates whose development has thus far been observed have the same general mode of growth.

The mode of development of the garden snails of Europe (*Helix pomatia* and *H. nemoralis*) is discussed in an elaborate manner by Dr. Hermann von Jhering, so that now we have tolerably full knowledge of the mode of growth of the land and fresh-water snails.

M. Gerbe finds that oysters are fitted for reproduction from the first year of their life. Among these precocious mothers there are some whose shell, in transverse diameter, measures hardly twenty-five millimeters. Hence the prosperity of the reproducing portion of a natural oyster-bed does not depend only on the presence of large oysters. The quantity of eggs, indeed, is generally in proportion to the size of the oyster. Many oysters, especially the young, propagate twice in the season, under favorable conditions. The laying of eggs occurs at long intervals, possibly corresponding to lunar phases.

Within two years many important works on shells and shell-fish have been published in Europe; while in this country it would appear as if our conchologists were resting on their oars. The deformities of mollusks and their shells have formed the subject of a work by Clessin. He divides the subject into three categories: (1) Monstrosities, being changes in shape of considerable amount, limited to the animal; (2) modifications in the shell caused by affections of the living organs from without; and (3) anomalies in shells caused by mechanical injuries, not affecting the animal.

An elaborate memoir, by Professor Steenstrup, on the cuttle-fishes, with a description, accompanied by beautiful plates, of a new form (Hemisepius), appears in the Memoirs of the Royal Danish Academy. This singular short cuttle-fish was discovered at Table Bay, Cape of Good Hope.

The shells collected by Dr. Kidder, naturalist of the Transit of Venus Expedition, at Kerguelen Land, have been, according to the *American Naturalist*, worked up by Mr. W. H. Dall, who describes three new genera. One of these was described in England under the name *Eatonia;* but as this name was long since preoccupied by

Professor Hall for a genus of brachiopods, the name *Eatoniella* is substituted. Mr. Dall also describes a genus allied to *Ceropsis* of the *Carditidæ*, giving it the name *Kidderia*, in honor of the naturalist of the expedition. A new genus of chitons is described by Dr. P. P. Carpenter under the name *Hemiarthrum*.

Mr. W. H. Dall describes the way in which the eggs are set free from the ovisac and cavity of the body of the limpets, in which no opening could be found. The minute size and fragility of all the parts was one obstacle. Not long ago, however, Mr. Dall had an opportunity to dissect several limpets of extraordinary size which Professor Agassiz brought home from the *Hassler* expedition, and found one in which the ovaries were full of eggs. He has observed that those eggs which lay at the extremities of the ovisac nearest the renal sacs were granulated, congested, and much riper than the rest, and that very minute orifices allowed of communication between the ovisac and the renal sac. Further examination showed still riper eggs in the renal sac itself, and, as it were, drifting toward the external opening, through which they passed into the sea-water.

The Academy of Sciences has received from M. P. Fischer a paper on the hypsometric distribution of mollusca—that is, the altitudes at which they are found. It is a striking fact, says Galignani, that plants thrive on mountains with great regularity, each at a certain height. Every species has its peculiar habitat, and if the mountain exceeds 8000 or 9000 feet, vegetable life gradually disappears near the summit. The terrestrial mollusca, being unprovided with means of locomotion enjoyed by birds and insects, and being, moreover, dependent upon vegetable life for food, could not, our author thinks, fail to be distributed in the same way as plants, and this supposition is confirmed by observation. Each species extends to an altitude the limits of which it does not overstep. M. Fischer has verified this in the Central Pyrenees as well as in the Alps, and divided the altitudes into five zones, comprised between 1500 and 7500 feet. Each zone is distinguished by the name of a species of *Helix*. Thus in the Pyrenees the first zone, ending at a height of 3000 feet, is called that of *Helix carthusiana;* the second, ending at 3600 feet, *H. aspersa;* the third, terminating at 4500 feet, *H. limbata;* the fourth, limited at 6000 feet, *H. nemoralis;* and the fifth, ending at 7500 feet, *H. carascalensis*. In the Alps, at the same altitudes, the names of the zones are respectively *Helix carthusiana*, *obvoluta*, *Fontenelli*, *sylvatica*, and *glacialis*. A few individual mollusks may, indeed, climb as high as 9000 feet, but they will stop at the limit of perpetual snow. Various genera of fluviatile mollusks do not ascend higher than 3000 feet—a circumstance of some importance to geologists, since it proves that in the quaternary beds the fossiliferous strata containing those genera, such as *Neritina*, etc., were deposited at small altitudes.

Many fish are afflicted by crustaceous parasites, called Argulus, which adhere to the gills. Dr. Claus has recently published an elaborate description of the variable form known as *Argulus foliaceus*. It is a parasite on a great variety of fishes, also on toads and tadpoles, and even on the axolotl or larval salamander.

The habits and nature of the limbs of trilobites is a matter about which there is much difference of opinion among naturalists. Some consider that they had broad, leaf-like swimming appendages; while others think they were like the modern Serolis, a sowbug-like form; and others compare them to the horseshoe crab, which both burrows and swims, walking through the mud, and at times swimming on its back, by means of its broad, leaf-like, abdominal feet. As a contribution of some value to this subject is a paper by Mr. C. D. Walcott, printed in the Annals of the New York Academy of Sciences, formerly the Lyceum of Natural History. His observations, based on the examination of 1160 specimens, lead him to believe, with Burmeister, that they swam on their backs, as out of 1160 specimens 1110 lay on their backs. The author seems to agree with the following conclusions, reached by Burmeister: (1) that these animals moved only by swimming, that they remained close beneath the surface of the water, and that they certainly did not creep about at the bottom; (2) that they swam in an inverted position, the belly upward, the back downward, and that they made use of their power of rolling themselves into a ball as a defense against attacks from above; and (3) that they most probably did not inhabit the open seas, but the vicinities of coasts, in shallow water, and that they here lived gregariously, in vast numbers.

The reproductive organs of the decapod *Crustacea* have been studied afresh by M. Brocchi, who concludes that neither the position nor the form of the genital orifices can furnish characters for classifying the macrourous forms (lobsters and shrimps), while in the crabs they are, with the external organs, of value for distinguishing families and species. References are made to works on this subject by the American naturalists Stimpson and Ordway.

The volume on parasitic animals, by Professor Van Beneden, lately published, will introduce our readers to the subject of commensalism. A new example is given by Dr. Streets in the *American Naturalist*, in the case of a crab found living in the cloacal dilatation of the alimentary canal of a sea-cucumber or holothurian living among the islands of the Pacific Ocean. The crab belongs to the family *Portunidæ*, or swimming-crabs, though an aberrant form. It is not only a new species, but, with another species found by Dana at the Fiji Islands, forms the type of a new genus.

It has been asserted by Bell, contrary to the supposition of Vaughan-Thompson, that the young of the land-crabs, like the lobster and crawfish, have the same form when hatched as their parents. The

late Dr. Suhm, of the *Challenger* expedition, however, found some eggs of a land-crab belonging to the genus *Cardiosoma* containing young ones which "were not like their mother, but zoeās." It is probable that the larvæ, called zoeæ, leave the mother, and lead a pelagic life until they have undergone all their wonderful metamorphoses.

Some facts regarding the habits in confinement of the blind crawfish of the Mammoth Cave, and the restoration of lost parts, are given by Mr. F. W. Putnam in the Proceedings of the Boston Society of Natural History.

The classifications of the Scorpions have been revised by Professor T. Thorell, his arrangement being based on that of Peters. It seems that there are about ninety species of scorpions in existence.

Ascending to the insects, besides many papers describing new forms by leading American and European entomologists, we would call special attention to certain new general discoveries.

The embryology of the flea, *Pulex felis*, has been studied anew by Balbiani. So far as the long abstract published of his work is concerned, no mention is made of an essay on this subject, illustrated with numerous figures, by the writer, published in 1872 in the Memoirs of the Peabody Academy of Science, wherein a number of facts supposed by Balbiani to be new are mentioned.

The embryo of the white ant (*Calotermes*) has for the first time been figured by Fritz Müller in the Jena *Journal of Science*. From this single figure it would seem that the white ant is similar in its mode of development to other insects, especially the dragon-flies.

Papers on the fossil insects of Colorado and Nova Scotia have appeared from the pen of Mr. Scudder, and several new European fossil insects have been described in foreign journals. Mr. Scudder calls attention in the *Geological Magazine* to the "constant discovery of close relationship between the ancient forms of insect-life in Europe and America, which Mr. Woodward has been one of the most conspicuous in pointing out." A list of described orthopterous American insects from the Carboniferous formation, by Mr. Scudder, appears in the same connection.

We have already referred to Weismann's remarkable paper on seasonal dimorphism, and to the fact that important data regarding the varieties of *Papilio Ajax* of this country were afforded by Mr. W. H. Edwards, the author of the beautiful work on butterflies now being published in this country. Further experiments are detailed in the *Canadian Entomologist* for December, which has just appeared. Mr. Edwards' paper will prove exceedingly interesting. He subjected a large number of chrysalids of what would have produced the variety Marcellus to severe cold in an ice-house, and found that the cold completely changed a part of them to Telamonides. He regards the variety Telamonides as the primary form of the species. We

thus have in this and similar experiments examples of the artificial breeding of different varieties of insects at will, and it is not impossible that results of a practical nature may follow when applied to some of our injurious species.

The relation of bees to flowers is discussed by Hermann Müller in a paper translated in *Nature*. He calls attention to the interesting facts presented by various groups of *Hymenoptera*, in which occur a series of forms presenting more and more complex life relations, accompanied by a higher and higher mental organization. The consideration of these gradations is calculated to throw much light on the question, "How has the honey-bee acquired its remarkable instincts?"—a question which the study of that species alone would, in his opinion, do little to solve, but on which the habits and organization of the lower group throw much light. Dr. Müller, after giving the evolutional history of the sting of the wasp, tracing it up from the ovipositor of the ichneumon-fly and saw-fly, thinks that the various acts by which the solitary wasps protect their young must have at first been arrived at with a consciousness of the object to be effected, but that they have gradually become instinctive, and are now unconsciously inherited from generation to generation. "Still it is," he observes, "impossible to watch a wasp at work without feeling that, with these inherited customs or so-called instinct, much individual effort also comes into play."

Mr. Riley's eighth report on the noxious and beneficial insects of Missouri contains much valuable information regarding the common and more injurious insects of the Western States, particularly the Colorado potato-beetle, canker-worm, army-worm, the Rocky Mountain locust, and the grape phylloxera. Public attention is annually turned to these destructive pests; and the careful studies of Mr. Riley, set forth in clear, forcible language, will do much toward enlightening the agricultural mind. If the other states were as intelligent and liberal in providing for the publication of such reports, co-operation could be secured between the inhabitants of different states, and the more injurious insects combated and held at bay.

Among other new entomological tracts are Baron Osten-Sacken's "Prodrome of a Monograph of the Tabanidæ of the United States," in which it is stated that there are 102 species of horse-fly (*Tabanus*) in America north of Mexico, of which twenty are new to science.

Mr. Scudder publishes in the Bulletin of the Buffalo Society of Sciences the second part of his synonymic list of the butterflies of North America, and in the *Canadian Naturalist* figures and describes the hind body of the larva of a dragon-fly and a part of the wing of a cockroach from the carboniferous formation of Cape Breton.

Dr. Hagen describes some curious insect deformities, such as butterflies with caterpillar heads, etc., in the Memoirs of the Museum of Comparative Zoology.

The young or larvæ of certain cave beetles from the Mammoth and adjoining caves are figured and briefly described by Dr. Packard in the *American Naturalist* for May. It appears that the young as well as the adult beetles are blind, otherwise they do not differ much from the young of allied genera. The beetles are *Adelops* and *Anophthalmus*. Besides these, a blind coleopterous larva belonging to an unknown species was discovered in the Carter caves in Eastern Kentucky. Remarks are also made on the degree of variation in these cave insects, which seems due more to varying means of subsistence than any other cause. The amount of variation, however, is very slight.

It has been found that certain Australian moths are capable of puncturing orange-skins by means of their proboscis or spiral tongue. It seems that the ends of the two halves of the tongue are stiff and barbed, and present on the under side three parts of the thread of a screw, while their sides on the upper surface are covered with short spines, springing from a depression, with sharp, hard sides. The object of these spines is to tear the cells and the pulp of the orange, as a rasp opens those of beet-root, to extract the sugar.

A writer in the *American Naturalist* notices an interesting instance of intelligence in the hawk-moth (Sphinx). While watching the sudden unfolding of the flowers of the *Œnothera Lamarkiana*, he observed that the hawk-moths never visited the same flower twice, even when frightened away by some motion made by the observer. On returning, they would go only to those flowers that had opened during their absence or that had not been visited before their flight.

In the fifth Bulletin of Hayden's United States Geological Survey of the Territories is a list of the bugs (Hemiptera) of the region west of the Mississippi River by Mr. Uhler, who has for so many years devoted himself to these insects. A number of new forms are described. The article is made still more useful by the addition of three excellent plates.

Professor Stoll, of Stockholm, has published an extensive work on the hemipterous insects of the world, one half of the work relating to those of North and South America.

Professor Riley's "Notes on the Yucca Borer" (*Megathymus yuccæ*), reprinted from the Transactions of the Academy of Science of St. Louis, is an interesting account, well illustrated, of a butterfly which bores into the root, tunneling it for most of its length. The insect is sufficiently common in the Gulf States to be sometimes found in every third plant over extended regions, its work rendering the yucca worthless as a hedge plant.

The geometrid moths, numbering in the United States some four hundred species already known, have been monographed by the writer, in a quarto work of over six hundred pages, with thirteen

plates, forming Vol. X. of Hayden's reports of the United States Geological and Geographical Survey of the Territories. The descriptive portion is preceded by chapters on the anatomy of the head and thorax, on secondary sexual characters, etc., while the volume closes with an essay on the geographical distribution of the species in this country.

It is generally supposed that, while the tropics abound in large, strong insects, there are not so many kinds like those of temperate regions—small and of modest colors. It appears, however, that the number of small forms is as great as in the temperate zone. For example, of the family of Rove beetles (Staphylinidæ) Dr. Sharpe estimates the probable number existing in the valley of the Amazon at from 4000 to 5000. And Mr. H. W. Bates, who spent several years (we believe nine) on the Amazon, states his belief that the proportion the smaller forms bear to the larger is as great in Brazil as in Europe; but the larger forms were, of course, more commonly captured in a country where so many new and fine species were to be found.

New observations on the mode of respiration of the water-boatman (*Notonecta undulata*) have been published by the writer, in "Half-Hours with Insects." This insect is boat-shaped, the keel of the boat being its back, the deck its ventral aspect. Along the middle of the under side of the body is a longitudinal ridge; a broad gutter between this ridge and the sharp edge of the body is bridged over from the head to the abdomen by a layer of dark, coarse, oblique hairs, and a layer of less oblique hairs arises on each side from the middle of the ridge. These hairs thus form a false upper deck. The creature rises to the surface, the end of the body projecting slightly out of water; the air passes up on each side along the tunnel under the hairs, and collects in bubbles above the base of the legs. Along the bottom of this tunnel are six pairs of spiracles into which the air passes. The air in the specimens he observed did not adhere to the hairs of the hind-legs, as Siebold says it does, nor, as he states in his "Comparative Anatomy," translated by Burnett, does the air for respiration as a rule pass under the elytra, since the spiracles are not situated on the upper side of the body, but on the under, and quite a distance from the edge of the body. Nor does this insect breathe at all, as Westwood states, like Dytiscus, in which the spiracles are situated on the upper side of the body, so that the air enters readily under the elytra. When it takes in the air, the tip of the abdomen is thrust up just above water, and an orifice is formed by the separation of the hairs at the end of the keel, which form the larger part of the mouth of the orifice, the remainder being composed of the hairs fringing the movable terminal plates of the body. The air thus passes in between the false deck of hairs and the under side of the body. When the insect is taken out of the water the

hairs cling to the sides of the body, revealing very distinctly the breathing-holes. Some air occasionally penetrates under the elytra, and remains there most of the time. Often the whole under side of the body between the pairs of legs is a continuous bubble, like a mass of quicksilver or molten lead. The *Notonecta* often rises for a new supply of air before the old is exhausted.

Another water-bug, the *Corixa*, is less tame, and does not come to the surface nearly as often as *Notonecta*. It receives its supply of air in an instant, and darts down to the bottom. It does not swim in an inverted position. It takes in the air so suddenly that it is impossible without patient observation to see the mode, which has not been described. It rises to the surface in a horizontal position, and no sooner is the surface reached than it darts to the bottom, and in one instance remained there for ten minutes, and then darted up again, leaving an air bubble in its wake, which rose to the top afterward. It carries down with it a broad, silvery streak along the side of the body. The air is really introduced under the head and front thorax. The head is large and very movable, as well as the prothorax. It slides back and forth on a thin membrane, from the surface of which it can be raised. So with the hinder edge of the prothorax, which rides over the membranous hind thorax, which it nearly conceals. When the *Corixa* rises to the surface it floats in a horizontal position, the hind edge of the head and the prothorax rising slightly above the surface. Now slightly raising the back of the head and the hind edges of the prothorax, a space appears in front of and behind the prothorax, by which the air passes into the breathing-holes beneath. This is proved by the small bubbles of air remaining in these two cracks. Two minute spiracles may be detected in deep pits, one on each side, just above the insertion of the legs, and from which the tracheæ arise, each one dividing into three irregular short branches, as may be seen by detaching the segment and holding it up to the light.

VERTEBRATE ZOOLOGY.

By Dr. THEODORE GILL.

Vertebrate Zoology has received the average amount of attention devoted to it for the last few years. Valuable contributions have been made to the morphology and anatomy of the branch, and its several classes; numerous species have also been added; and several very interesting new types have been made known. Unquestionably the most noteworthy of these are several forms collected in the Australian and Ethiopian realms: these are (1) a species of the genus *Tachyglossus* or *Echidna*, which has been supposed hitherto to have been confined to Australia and Van Diemen's Land; (2) a remarkable new generic type, representing a previously unknown family, found in Africa; and (3) a second genus of the hitherto monotypic class of Leptocardians. The significance of these discoveries will be made manifest in our subsequent remarks.

Almost if not quite the most interesting of animals has been the *Branchiostoma lanceolatum* (often called *Amphioxus lanceolatus*), until lately the type of the only known genus of not only a class, but even, in the opinion of many, a primary group or "superclass" of the branch of vertebrates. The genus owes its interest and importance to the fact that it is, to most intents and purposes, an "invertebrate vertebrate;" and that it gives, in its organization, the chief if not the only clew to the derivation of the vertebrate phylum in its differentiation from the mass of the animal kingdom. Through the careful study of that interesting form, naturalists had arrived at the conclusion that the vertebrates were derived in all probability from the molluscoid Tunicates. Unusual interest is, therefore, attached to the discovery of an apparently well-defined second genus of the family. Its type was discovered in Moreton Bay, North Australia, by the captain of the German Imperial vessel *Gazelle*. The new genus differs from *Branchiostoma* in the development of a high dorsal fin; in the want of a distinct caudal as well as anal fin; and in the symmetrical median (not lateral) position of the anal aperture. It appears also to present some differences of detail in the structure of the mouth and oral tentacles; but these characters require yet to be elucidated. The type of the genus is much smaller than the species of the genus *Branchiostoma*. Ten specimens obtained vary from thirteen to twenty-three millimeters in length. The newly discovered type has been described by Dr. Peters, of Berlin, under the name of *Epigonichthys cultellus*. The generic name was apparently given in allusion to the

type being the second of its class made known (ἐπίγονος, later born, or born of a second marriage, and ἰχθύς, fish).

Notable contributions to ichthyology have been made relative to the groups as well as to the faunas of several countries.

A new form of fishes was discovered by Herr Buchholz in a small stream in Victoria, emptying into the Victoria River, in West Africa. The species is of small size, and in external appearance has considerable resemblance to a Cyprinodont, and especially to species of the genus *Haplochilus:* it is really, however, closely related to the *Osteoglossids* of South America and Australia, and has no real affinity with the *Cyprinodontids:* it is covered with cycloid scales, furnished with the radiating fracture-like markings characteristic of the Osteoglossoid series; its head is flattened above; its cheek protected by the enlarged suborbital bones; no interoperculum or suboperculum are developed; the mouth is very fully provided with teeth; the dorsal fin is situated far behind, and is very short and high; the anal fin is also short, but more developed than the dorsal, and more anterior; the ventral fins are rather far advanced forward, although, of course, still abdominal. The relations of the type are evidently with the family with which it has been compared—*i. e.*, the osteoglossids; and the importance of its discovery is due chiefly to this affinity. It has been claimed by several observers that there is in many respects a close relationship between the African and South American faunas, and that this relationship is evidence of the former closer connection of the two continents; these as well as the Australian continent furnish not a few proofs that they have derived their animal inhabitants from a common but very remote primitive source. The newly discovered fish furnishes another decided argument in favor of the truth of this view. It has been named *Pantodon* (in allusion to the numerous teeth) *Buchholzi.*

A characteristic type of fishes of the Northern Atlantic is exemplified in the species variously called "Sea-Wolf," "Wolf-fish," and "Cat-fish." This species (the *Anarrhicas lupus* of naturalists) is common to both sides of the Atlantic, and is well known in connection with its powerful jaws, and its consequent ability to wound and otherwise injure fishermen. The other species of the genus have been involved in considerable obscurity. In the past year, however, Professor Steenstrup has published, in Danish, a monograph of the genus, in which he has demonstrated that in the extreme northern seas, and especially the Greenland waters, no less than four species are found, which represent two quite distinct minor types or subgenera, one (*Anarrhicas* proper) containing two species (*A. lupus* and *A. minor*), and the other (*Lycichthys*) containing also two, but less known species (*A. latifrons* and *A. denticulatus*).

Among the contributions to knowledge of the Ichthyic faunas of

various countries, probably the most interesting are respectively the monograph of the fishes of the Aralo-Caspio-Euxine basin, by Professor Kessler; the Catalogue of the Fishes of the Bermudas, by Professor G. Brown Goode; and the summary of the fishes of the high mountainous lake of Peru, Titicaca, by Mr. S. Garman. These owe their interest to the isolated positions or other geographical relations of the regions in question.

The number of fishes in the great interior basin first alluded to is unexpectedly large, considering the latitude and character of the surrounding country; about 280 have been recognized by Professor Kessler. Doubtless the most interesting development, to Americans at least, is the discovery of not less than three species of the genus *Scaphorhynchus* (a genus belonging to the sturgeon family), of which, until lately, but one species had been known, and that a familiar inhabitant of the Mississippi Valley.

Nothing of a special interesting or novel nature has been published on the class of Amphibians.

In the class of reptiles, the discovery of a second species, or at least supposed species, of the genus *Sphenodon*, or *Hatteria*, deserves notice. The genus *Sphenodon* had hitherto only been known to contain one species, and that the sole existing representative of a formerly richly developed order. The first species appears to be confined to Karewa Island, in the Bay of Plenty, New Zealand; and the second species has been discovered in the Brother Island, also of the New Zealand archipelago.

In Ornithology quite a number of valuable contributions have been made to the morphology and taxonomy of various groups by Garrod, Kidder, Coues, and others; and the faunas of a number of countries have received attention from systematic ornithologists.

One of the most interesting publications on classification is a monograph on *Chionis* and its relations, by Drs. Kidder and Coues. This genus is confined to the southern hemisphere, where it is represented by two species; one found at the extremity of South America, etc., and the other on Kerguelen Island, etc. The affinities of this form were long involved in much doubt: it had, according to some, passerine relations; according to others, gallinaceous ones; but, in the opinion of most recent ornithologists, it was most nearly related to the plover-like birds, and especially the genus *Hæmatopus*. It now appears, however, from the investigations of Kidder and Coues, that it is nearer of kin to the gulls than any other birds; but that its relations, to some extent, are intermediate between the plovers and the gulls. The authors cited have therefore recognized it as the type of a primary group or "super-family" of birds under the name of *Chionomorphæ*, which is intercalated between the *Charadriomorphæ* and *Cecomorphæ*.

The contributions to our knowledge of the avifaunas of regions

have been, as has been the wont for a number of years, quite multitudinous. Among them three may be especially enumerated on account of the interesting nature of the regions in question, as well as in connection with a certain law of development which they suggest: these are respectively a catalogue of the birds of the Galapagos Archipelago, by Mr. Salvin; a descriptive list of the species of the Californian Guadelupe Islands, by Mr. Ridgway; and an article upon the parrots of the Mascarene Islands, by Professor Newton.

Mr. Osbert Salvin, in his memoir "on the Avifauna of the Galapagos Archipelago," adds much to the information previously possessed of the birds of that remarkable group of islands. These islands are about fifteen in number, and are clustered under the equator about 600 miles west of the coast of South America. They are remarkable for the number of peculiar species of birds. Fifty-seven are now known from the different islands, thirty-eight of which are peculiar to one or more of them, and only nineteen (and those mostly water-birds, or species possessing great power of flight) have been found elsewhere. These fifty-seven species represent thirty-nine genera, of which five are peculiar to the islands, seven are common to them and the contiguous coast of America, and the remaining twenty-seven are types of wide distribution. The entire avifauna is a striking exemplification of the modifications concomitant with isolation and peculiar conditions.

Mr. Ridgway's article "on the Ornithology of Guadelupe Island" was "based on notes and collections made by Dr. Edward Palmer." The Guadelupe Island meant is situated between latitudes 28° 45′ and 29° 10′ north, and is distant about 220 miles southwest from San Diego. The species known are but few in number, only eleven land-birds having been identified; and of these only eight are known from specimens. All of those thus known are either distinct specifically, or as varieties, although, as was of course to be expected, they are congeneric with and near allies to species of the adjacent mainland.

The extent to which certain groups are developed under exceptional conditions, and their liability to extermination on the intrusion of extraneous agents, have been well exemplified in the history of the Mascarene Islands. These islands, including Mauritius, Reunion, Rodriguez, and the Seychelles, were within the historical period the abode of some remarkable birds, among which the Dodo and the Solitaire were the most conspicuous. These were uncouth small-winged birds which lived on the ground and attained a large size, and this development was doubtless due to the absence of carnivorous mammals or other formidable enemies. The history of their extermination is familiar to naturalists; but it is not so well known that other birds have undergone or are now approaching a similar fate. Some of these were also imperfectly endowed with

power of flight. One group thus affected has been lately elucidated by Messrs. A. and E. Newton in a memoir "on the Psittaci of the Mascarene Islands." It appears that each of the four islands of that group had at one time at least two species of parrots, among which were even two generic types; one (*Necropsittacus rodericanus*) confined to Rodriguez, and another (*Lophopsittacus mauritianus*) restricted to Mauritius. These two are now known only from their fossil remains—save that in one case (*Lophopsittacus*) the external characters are traceable from a figure made by an old Dutch traveler. The other species have also become exterminated, or exist in diminished numbers. Thus in Mauritius one is entirely extinct, and another exists in decreased numbers; from Reunion two formerly indigenous species have entirely disappeared; in Rodriguez one species is now also entirely extinct, and another nearly so; and only in the Seychelles Islands are the two species found in any number, but even they are receding, and apparently doomed to the fate of their relatives.

A study of these several memoirs, and the data on which they are based, and especially a comparison of the measurements of the insular species thus referred to with those of continental areas, reveals the fact that the island forms have at least a decided tendency to abbreviation of the wings and development of the legs in proportion to each other as well as to the bill. These characteristics, it is true, have not been adverted to in the memoirs enumerated; but they become evident upon a comparative examination of the species signalized by them and allied continental ones. The restriction of the areas and the paucity of carnivorous enemies, which detract from the necessity of flight, and induce the greater use of means of terrestrial progression, are doubtless the determining causes of these peculiarities.

For the class of mammals one discovery merits special mention, and several monographs of different families or genera of special interest have been published.

The order of *Monotremes*, the lowest and most generalized type of mammals, and which differs in the most marked manner from all other types of the class, has hitherto been supposed to be confined to Australia in the present geological epoch. In that continent it has furnished two very distinct forms or representatives of distinct families—*Tachyglossus*, or *Echidna*, and *Ornithorhynchus*. During the past year, however, the collectors of Mr. Bruijn, of Ternate, obtained from natives, on a peak of the Arfaks called Mickerbo, in the island of New Guinea, two imperfect skulls of a mammal which evidently is a typical member of the family *Tachyglossidæ*. This has very lately (December 3, 1876) been described by Messrs. W. Peters and G. Doria as a new species of the genus *Tachyglossus*, under the name *T. Bruijnii*. It nevertheless differs markedly from the *T. hystrix* and *T. setosus* of Australia in the much more elongated and

nearly uniformly or very gradually attenuated and decurved rostrum, as well as in the contour of the palate, etc. So great are these differences that consistency with the generally accepted canons regulating generic differentiation among the mammals necessitates the expression of those differences in nomenclature by special generic designations, and the newly discovered form may therefore be appropriately contrasted under the name *Zaglossus* (Ζα, augmentative particle, and γλοσσα, tongue) *Bruijnii*, with the previously known *Tachyglossus hystrix* and *Tachyglossus setosus*. The Papuan species is very much larger than the Australian ones, and was described by the natives as being about as large as a dog, and having a decided tail, and long, harsh fur. The external characters therefore, probably, also contrast with those of the Australian animals. The species is highly esteemed by the Papuans as food, and is hunted down by dogs. It conceals itself in small caves, and must be either rare or difficult to catch, as the hunters of Mr. Bruijn were unable to obtain more than the two skulls referred to.

Of the monographs published the most noteworthy are those of Professor Flower, on the existing species of Rhinoceros, and Mr. J. A. Allen, on the existing and extinct species of Bison of the American continent. Mr. Alston's memoir on the classification of the Order of Rodents will also be found to be of service.

Having thus given some idea of the principal contributions to the knowledge of existing vertebrate faunas, we now pass to the consideration of a few of those elucidating the extinct faunas. Our restricted limits permit us only to do little more than refer to those relative to the animals which formerly inhabited the countries at present embraced within the limits of the United States. These contributions have been chiefly, as for several years past, by Marsh, Cope, and Leidy.

During the period immediately preceding our own, the terrestrial vertebrates that ranged over our territories were essentially the same as those that now live here; it has been shown, however, that on the whole the mammals at least were larger in size. This was first proved, on a considerable scale, by Professor Baird, and recent results have corroborated his conclusions. In 1876 Mr. J. A. Allen described, from the lead-bearing regions of Illinois, the remains of a deer and wolf analogous respectively to our recent *Cariacus virginianus* and *Canis lupus*, but which are considerably larger, thus confirming the generalizations already enunciated.

In the Miocene epoch existed a fauna quite different from our present one. The forms that then flourished, and which were among the most characteristic of the time, apparently died out with that epoch, without leaving any lineal descendants. One of the most remarkable of the forms of the Lower Miocene was a peculiar type of mammals related to the family of Rhinocerotids of the present time,

which latter are now confined to the tropical parts of the so-called Old World. In past periods, however, that family was well represented within the present boundaries of the United States; and at a still more remote period—*i. e.*, in the Lower Miocene—forms related to the living type, but which were differentiated by quite distinct characters, and which were very closely related to at least the progenitors of the recent Rhinocerotids, existed in numbers in what is now Western America. This type, which has been distinguished as a family by Professor Marsh under the name of Brontotheriids, was closely related to the Rhinocerotids, but differed in details of dentition and the feet, as well as the armature of the head. The typical species, at least, were provided with horns, arising not from the median line, as in the present Rhinocerotids, but from each side of the nose. The brain was also very much smaller than that of the Rhinocerotids of the present epoch. According to Professor Marsh, four generic types can be recognized: these have been distinguished under the names (1) *Menodus* or *Titanotherium*, (2) *Megacerops*, (3) *Brontotherium*, and (4) *Diconodon*. These are again combinable into two groups, one composed of the first and second, and the other of the third and fourth genera. All the known remains of the family have been obtained from east of the Rocky Mountains, in the Lower Miocene beds of Dakota, Wyoming, and Colorado. It is quite possible, however, if not probable, that the family is identical with the Chalicotheriids which existed at nearly the same period in India as well as in Europe.

At an earlier epoch of the history of our continent (the Eocene) existed a still more characteristic type, which has been isolated by Professor Marsh as even a distinct order of Mammals, under the name of Dinocerata. The animals so distinguished were closely related to the Proboscideans (elephants, etc.), but of a much more generalized type; like them, they had columnar legs and pentadactyle feet, but the articulations of the tarsals and carpals severally with each other and with the proximal segments of the limbs were quite different. These animals, like the *Brontotheriidæ*, were also distinguished by their formidable armature; some of them, at least, are believed to have had as many as three pairs of horns—two frontal, two supraorbital, and two nasal. They were moreover provided with very large and trenchant or sabre-like canines; the incisors were rudimentary, or entirely obsolete; the molar teeth were very small; the brain was still smaller than in the *Brontotherium*, although the animals were in some cases at least as large as elephants. All the certainly known representatives of this group have been found in the Eocene beds of Wyoming.

During the same epoch in North America lived another peculiar type, and which has also been distinguished as a special order of mammals by Professor Marsh under the name *Tillodontia*.

These forms have quite a characteristic combination of characters: the skull of the known species has superficial resemblance to that of a bear; the incisor teeth were much like those of rodents, being two in number in each jaw, and apparently reproduced by gradual growth from their bases; the molars resembled those of the pachyderm ungulates; the feet were pentadactyle; the scaphoid and lunar were separate from each other; the digits provided with claws. This unusual combination of characters can not be reconciled with the accepted diagnostic marks of any of the existing orders; and either the generally admitted definitions or the orders of the present age will have to be modified to include these extinct forms, or the forms thus left must remain, as indicated by Professor Marsh, as representatives of a distinct order. The brain, as in the *Dinocerata*, was very small in comparison to the bulk of the animal, although (as might have been premised from the size of the animal) much larger in proportion than in the latter. The species known were smaller animals than those of the group just noticed, the best known species of *Tillotherium* being only about half or two thirds the size of the common South American tapir.

In the same Eocene period, and perhaps contemporary with the last, lived a horse-like animal of a still more generalized type than any of those which had previously been made known. This animal was about as large as a fox, but somewhat more robust in its proportions; the feet had well-developed digits—four in front; behind, three perfect, and a fourth ("fifth") rudimentary metatarsal; the radius and ulna in the fore limb, and the tibia and fibula in the hind, were distinct and well developed. The type so distinguished has been named *Eohippus* by Marsh, and two species have been recognized: it belonged, apparently, to the family of *Orohippidæ*, and probably was the nearest relative to the progenitors from which have descended the modern equine mammals.

Contemporary with these, and identifying their geological horizon, was an animal whose remains have been identified both by Marsh and Cope with the genus *Coryphodon*, long known by imperfect fragments from the Lower Eocene beds of Europe. The more perfect remains found in this country prove that the animal was a generalized perissodactyle ungulate of peculiar family, with five digits, and not at all nearly related to the living Tapirids or the allied Lophiodontids, as has been generally supposed.

The mammals of the Eocene are the earliest of the higher types of the class that have yet been discovered: between them and those of the Trias a great blank intervenes, representing an enormous period, and deposits of vast thickness, which have yielded up to the present time no certainly identified remains of mammals, although, of course, they must have been living during the whole of that epoch. The conditions of life were very favorable, however, for the develop-

ment of reptile life, and representatives of that class were the monarchs of the time.

The Cretaceous epoch in this country, as in Europe, was distinguished by the great development of certain peculiar reptiles. Among these the most characteristic and strange in many respects were the *Pterodactyles*, or Flying Lizards. Not long ago these were supposed by some not to have lived in America, but now quite a number of forms have been discovered in this country. Among these were some distinguished from the forms previously known from Europe by the absence of teeth, and with this condition were co-ordinated other characters: these animals have, therefore, been distinguished under the name *Pteranodon*, and even presented as the representatives of a suborder (*Pteranodontia*) distinct from other pterosaurians, which, as tooth-bearing animals, must then be contrasted under the name "Pterodontia."

From certain strata of the Territory of Montana, whose age has been disputed, Professor Cope, in a recent expedition to that region, has obtained numerous species of reptiles, especially of the order of Dinosaurians. Some of these were of large size, and among them were apparently carnivorous as well as herbivorous species.

In a still earlier age of the secondary epoch, in widely separated parts of the world, a remarkable group of reptiles existed, which were characterized, according to Owen, by teeth resembling those of typical mammals, in that they had "incisors defined by position, and divided from the molars by a large laniariform canine on each side of both upper and lower jaws, and the lower canine crossing in front of the upper, as in mammalia." The earliest described remains of any representatives of the group were made known, but without appreciation of their systematic relations, by Russian naturalists, and were found in certain deposits in Russia that have been referred to the Permian age. In 1876 Professor Owen further elucidated the affinities of the group, and described a considerable number of species from rocks of South Africa which have been assigned to the Triassic epoch. These have been grouped into two sections or families—Binarialia, characterized by the external nostrils being divided by a narrow partition, and Mononarialia, distinguished by the external nostrils being single and undivided. To this group of Theriodontia has also been referred a form, described by Professor Leidy, from Prince Edward's Island.

BOTANY.

By W. G. FARLOW, M.D.,
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Although the present year has not been marked by any brilliant discovery in vegetable morphology or physiology, it has been productive in descriptive works, and in experiments which have proved valuable as confirming what was known or previously suspected, rather than as tending to revolutionize previous ideas.

DESCRIPTIVE BOTANY.

Among the descriptive works bearing more directly on the flora of the United States must be mentioned the first volume of the "Botany of California," published by the geological survey of that state, aided by contributions from private sources. This volume includes the *Polypetalæ* by Professor W. H. Brewer and Mr. Sereno Watson, and the *Gamopetalæ* by Professor Asa Gray. The volume, except that it is without illustrations, resembles in form the "Botany of the Clarence King Expedition," by Mr. Watson. Another contribution to the botany of the western country is the "Flora of Southwestern Colorado," by T. S. Brandegee, reprinted from Hayden's "Bulletin of the Geological and Geographical Survey of the Territories," Vol. II., No. 3. To this pamphlet Professor Asa Gray and Dr. Engelmann have contributed. In the "Proceedings of the American Academy of Arts and Sciences," January 5th, 1876, is a paper by Professor Gray, in which he describes a number of new American species, and gives a synopsis of American *Mimuli*. In the "Transactions of the Academy of Science of St. Louis" Dr. George Engelmann has published two valuable papers. The first, "Notes on Agave," December, 1875, but reprinted at a later date, contains a description of species of that genus, thirteen of which occur in the United States. The second article is a revision of the "Oaks of the United States." A series of plates of American flowering plants, by Isaac Sprague, with descriptions by Professor G. L. Goodale, is announced to appear at the close of the year. Descriptions of new American *Musci* and *Hepaticæ*, by C. F. Austin, have been published in the Bulletin of the Torrey Club; and new species of American fungi have been described by J. B. Ellis, Charles H. Peck, W. R. Gerard, Rev. M. J. Berkeley, M. C. Cooke, and Baron Von Thümen, in the Bulletin of the Torrey Club and Grevillea. New species of American Algæ have been described by Professor J. E. Areschoug in the *Botaniska Notiser*.

The two most important works on the phanerogams of foreign countries have been the second volume of the "Genera Plantarum," by Bentham and Hooker, which contains the genera of *Gamopetalæ*, and the second volume of the "Flora of British India," by Dr. J. D. Hooker. In French there has been a monograph of the *Pomeæ* by Decaisne, and continuations of the *Primitiæ Monographiæ Rosarum* by Crépin. In addition, there have been numerous less important contributions to our knowledge of different genera and orders which we can not particularize in the present connection.

The leading works on descriptive cryptogamy have been a third volume of the "Species, Genera, et Ordines Algarum," by Professor J. G. Agardh, of Lund, in which he gives a review of the *Florideæ*, but does not acknowledge the results of recent researches in arranging his classification; and "Notes Algologiques," by Gustave Thuret, edited by Dr. Edouard Bornet, the first fasciculus of which has appeared. The plates of the latter work deserve great commendation. Descriptions of new fungi and lichens are contained in numerous short papers scattered through the different journals. Among the more curious fungi are two genera, *Kalchbrennera* and *MacOwanites*, described by Berkeley in the *Journal of Botany*.

EXPEDITIONS.

During the present year a report on the botany of Kerguelen Island was made by Dr. J. E. Kidder in the Bulletin of the United States National Museum. The report showed interesting additions to the flora of that island, including phanerogams as well as cryptogams. The reports of different British botanists, Berkeley, Dickie, Eaton, and others, on the collections made by the British Transit Expedition, have been partially published in English journals, but have not as yet been collected into one volume.

VEGETABLE HISTOLOGY AND CELL STRUCTURE.

The structure of the cell has been discussed by Strassburger in "Ueber Zellbildung und Zelltheilung." A reply to Strassburger was made by Professor Auerbach in an article entitled "Zelle und Zellkern," published in Cohn's *Beiträge zur Biologie der Pflanzen*. Auerbach maintained that the cell nucleus consists of a fluid which in time surrounds itself with a wall, and which later contains a number of nucleoli. Strassburger in his work attacks this view of the nature of the nucleus, and says that "Auerbach has, at any rate, considered the vacuoles which form in the nuclei as the nuclei themselves." Auerbach rather acrimoniously replies to this, and the contest seems to be one relating rather to the use of certain technical terms than to a matter of fact. In Pringsheim's *Jahrbücher* Tschitstiakoff has published an article on the structure of the cell.

In the *Annales des Sciences* have appeared a second memoir by

Professor Duchartre, entitled "Observations sur les Bulbes des Lis," and a "Mémoire sur l'Anatomie de l'Écorce," by Julien Vesque, in which the structure of the bark is considered at considerable length, without, however, adding much to our knowledge in the way of newly discovered facts. In the *Botanische Zeitung* Bolle has given an account of the "Terminal Growth of the Angiospermous Root-cap," and Dr. Reuther an account of the "Development of the Flower." In the same journal Graf Solms-Laubach describes the development of the flowers of *Brugmansia Zippelii*, Bl., and *Aristolochia Clematitis*, L. In Pringsheim's *Jahrbücher* Reinke treats of the organs of "Secretion of Leaves," especially those found on the teeth.

INSECTIVOROUS PLANTS.

Since the appearance of Darwin's book on this subject, several observers, among whom is Professor Rees, have published results confirming Darwin's experiments with regard to *Drosera*, and Mr. Francis Darwin has published (*Quarterly Journal of Microscopical Science*, July, 1876) some details of the process to which his father applied the name of aggregation, in *Drosera rotundifolia*. With reference to the digestive powers of *Dionæa*, Dr. Fraustadt has made a careful study of the anatomy of its vegetative organs. The attention of botanists has more especially been turned of late to the digestive power of the *Sarraceniæ*, or pitcher-plants, concerning which an article appeared in *Harper's Magazine* from the pen of Mrs. Mary Treat. Mr. Burgess reported at a meeting of the Natural History Society in Boston that he had found that the lip of the leaf of *Sarracenia purpurea* secreted sugar. M. Casimir de Candolle, in a paper in the *Geneva Archives des Sciences Physiques et Naturelles*, doubts whether the animal matter caught by the leaves of *Dionæa* is utilized by them.

VEGETABLE PHYSIOLOGY.

Mr. Francis Darwin read before the Linnæan Society of London a paper on the "Hygroscopic Mechanism by which certain Seeds are enabled to bury themselves in the ground." The hygroscopic twisting of the awn on certain seeds he considers owing to the power of torsion in the individual cells. Professor Asa Gray, in the *Naturalist*, gives an account of some peculiar qualities of certain Borragina-ceous seeds. The "Influence of Light on the Color of Flowers" has been the subject of some experiments by Askenasy, who comes to the conclusion that in the majority of cases of plants grown in the dark the flowers are of the normal color. In the *Botanische Zeitung* Reinke has a long article on the growth of plants. In a later number of that journal Sachs complains that Reinke's method is borrowed directly from that pursued at Würzburg.

CRYPTOGAMY; HIGHER CRYPTOGAMS.

During the year the attention of botanists has been more particularly drawn to the *Hepaticæ* than to any other portion of the higher cryptogams. Prantl and Leitgeb have frequently discussed the subject in the journals and society meetings, but have not published articles of any length. In ferns, the development of the prothallus of the *Cyatheæ* has been studied by Dr. Bauke. Dr. Stahl, of Strasburg, describes the production of protonemata from the sporogonium of mosses.

LICHENS.

In a morphological point of view, very little has been done with this group during the year. The discussion of the Schwendener theory, which for the last few years has been very animated, has somewhat subsided. Winter has made contributions to the knowledge of the crustaceous lichens in the case of the genus *Sphæromphale.*

FUNGI.

In this department great activity has prevailed, both in the descriptions of new species, which have been limited principally to pamphlet articles, and in investigations with regard to the development of the different orders. The absorbing topic has been the fertilization, by means of a carpogone, of certain species of *Coprinus*, which was supposed to be the key to the development of all the *Hymenomycetes.* In 1874 Rees announced the discovery of a carpogone in *Coprinus*, and was soon confirmed by Van Tieghem, of Paris, in the *Comptes-Rendus*, February, 1875. A short time afterward, however, Van Tieghem reported in the *Comptes-Rendus* that he had been wrong in supposing that what he considered the *spermatia* were the male organs, as he had found subsequently that they germinated, and were consequently a form of stylospores. During the present year the discussion has been continued by Rees, Brefeld, and Van Tieghem in the *Botanische Zeitung* and *Comptes-Rendus;* and Van Tieghem and Brefeld both now believe that what was supposed to be a carpogone in *Coprinus* has nothing to do with sexual reproduction. Van Tieghem goes farther, and hints that the so-called reproduction by a carpogone is, in most of the *Ascomycetes*, an entirely asexual process, judging by his observations on *Chætomium*, which are not yet published in full. Brefeld denies the existence of any group of *Carposporeæ* as described by Sachs, founding his statement on the fact that in a new species of *Mortierella*, which belongs undoubtedly to the *Zygomycetes*, a carposporic fruit is developed. In the *Annales des Sciences*, Cornu gives in detail his "Observations on the Germination of Spermatia," which he thinks can not be considered male organs. Dr. Hermann Bauke has studied the development of certain pycnidia, and finds, as Tulasne has already

suggested, that they are simply conditions of species of *Pyrenomycetes.*

VEGETABLE PATHOLOGY.

In the Bulletin of the Bussey Institution are articles on the effects of *Fumago salicina* on orange and lemon trees in California, on the disease of grape-vines in America caused by *Peronospora viticola*, and on the "black knot" of plum and cherry trees. Mr. Charles H. Peck, in the Proceedings of the Albany Institute, has a paper on diseases of the Black Spruce. The potato-rot fungus was the subject of a communication made by Professor De Bary, of Strasburg, to the Royal Agricultural Society of Great Britain. He calls in question the statements of Worthington G. Smith that he had discovered the oöspores of *Peronospora infestans*, the fungus causing the rot, but thinks that the so-called oöspores may belong to a new species of *Pythium*, which he calls *Pythium vexans.* De Bary makes *Peronospora infestans* the type of a new genus, which he calls *Phytophthora.* On the other hand, Mr. Smith replies by an article in the *Gardener's Chronicle* that he has watched the germination of the oöspores, and finds that they reproduce the *Peronospora.* The question can hardly be settled satisfactorily until some competent person shall confirm the views expressed by one side or the other.

ALGÆ.

In the *Botanische Zeitung* Cienkowski describes the palmelloid state of a species of *Stigeoclonium.* Reinke, in Pringsheim's *Jahrbücher*, and Rostafinsky describe the apical growth of the *Fucaceæ*, finding that some genera, as *Sargassum*, have a single terminal cell, while other genera, as *Fucus*, do not. Sachs, in *Flora*, has some curious observations on the forms which zoöspores assume in water, which he ascribes to the mechanical action of currents rather than to a vital movement. In the *Beiträge zur Biologie* Cohn has some remarks on the organization of zoöspores.

BACTERIA.

Of the almost numberless articles on *Bacteria* which have appeared during the year, those by Bastian are almost the only ones in which the theory of spontaneous generation is still maintained. By far the majority of writers believe that bacteria as well as all other plants come from previously existing germs, and the object on the part of the botanists has been to trace the development of some one species. This has to a certain extent been done by Cohn in an article in the *Beiträge zur Biologie der Pflanzen*, in which he gives an account of the formation of spores of *Bacillus subtilis.* Cohn maintains that he has proved that the bacterial form which appears in fluids which have been boiled is not *Bacterium Termo*, but always a *Bacillus*, to which he gives the name of *Bacillus subtilis. Bacterium*

Termo loses its germinating power by boiling, while *Bacillus subtilis* does not. Dr. Koch, in the *Beiträge zur Biologie*, also gives an account of the discovery of spores in *Bacillus anthracis*, a bacterial form found in inflammation of the spleen. Among the more interesting species of bacteria studied during the year is *Bacterium rubescens*, formerly considered an alga, and called *Cryptococcus roseus*. Attention was first called to this species in the *Quarterly Journal of Microscopical Science* by Professor Lankaster, and more recently Cohn has written on the subject. These two writers do not agree as to the presence of cilia in certain conditions of this species. Observers of bacteria have often been troubled by the admixture of different species in the same fluid. To obviate this difficulty, Dr. Salowonsen, of Copenhagen, places his nourishing fluid in capillary tubes. If different species are produced they will appear in different parts of the tube, which can be broken at any desired point and a drop of fluid obtained.

DISTRIBUTION AND VARIATION OF PLANTS.

In an interesting article in the *Annales des Sciences*, M. Charles Contejean shows the important influence which the chemical nature of the soil exercises on plants. He finds that plants may be divided into well-marked groups, according as they are affected by different chemical ingredients of the soil. He distinguishes two floras—a maritime, including plants which require salt, and terrestrial, which can not endure a soil containing salt. The terrestrial flora is divided into calcicoles, or plants requiring a calcarcous soil; calcifuges, which avoid it; and indifferent plants, which are neutral toward it. Each of these four divisions is subdivided into xerophiles, plants preferring dryness, and hygrophiles, preferring a damp soil. M. Naudin, in an article on disordered variation of hybrid plants, mentions the case of a hybrid of *Lactuca virosa*, and a variety of the common lettuce. This hybrid did not show any tendency to vary, and M. Naudin maintains that a hybrid is nothing but a sort of living mosaic; each portion of which is reclaimed by the parent species.

NECROLOGY.

Leopold Fuckel died at Vienna, May 8th, while returning from a journey to Italy. He was for many years an apothecary at Oestrich, on the Rhine, and is known for his mycological writings, and his published collection of fungi, entitled "Fungi Rhenani."

Adolphe Brongniart died at Paris, February 18th. He was born January 11th, 1801, and in 1834 was chosen member of the Academy. He was the first fossil botanist of his time, and was employed upon an extensive work on fossil plants at the time of his death.

AGRICULTURE AND RURAL ECONOMY.

By Prof. W. O. ATWATER.

EXPERIMENT STATIONS.

European Agricultural Experiment Stations.—By far the largest part of the investigations made at present in agricultural science comes from the agricultural experiment stations. These institutions are indigenous in Germany. The first one was founded in Moeckern, in Saxony, in 1852. Since that time scarcely a year has passed without seeing new stations founded in Germany or other parts of Europe. In 1875 there were, as appears from statements in the *Landwirthschaftlichen Versuchs-Stationen*, the organ of the German stations, some 40 in the German Empire, of which Prussia had 21, Saxony 6, Bavaria 4, Baden 2, and Würtemberg, Saxe-Weimar, Mecklenburg-Schwerin, Hesse-Darmstadt, Brunswick, Anhalt, and Alsace-Lorraine 1 each. Of the other European countries, the Austrio-Hungarian Empire had 6, Italy 12, France and Switzerland 2, and Russia, Belgium, and Holland 1 institution each, which could be technically called experiment stations. Besides these sixty-five experiment stations, there were some twenty-five laboratories and other establishments, supported by agricultural schools, societies, or private individuals, and occupied with researches in agricultural science.

It is not easy to determine exactly the number of experiment stations in active operation in Europe at the date of the present writing—the close of 1876. That the number has increased very considerably during the year is evident from data gathered from a number of European agricultural and scientific journals and reports of stations, which make the number essentially as follows: German Empire, 50; Austrio-Hungarian Empire, 7; Belgium, France, Switzerland, and Russia, 2 each; Italy, 13; and Holland, 1—making 79 in all, besides nearly thirty laboratories not technically experiment stations, but whose work is, entirely or in part, the same as that of the stations proper. Some of the latter class are very well supported and efficient. Among these may be mentioned the following:

"The private laboratory and farm of Boussingault, at Bechelbronn, near Strasburg, in Alsatia, dating back, as a source of most valuable agricultural investigations, to the year 1835."

"The private laboratory and experimental grounds of John Bennet Lawes, Rothamstead, England, where, with the co-operation of Dr. J. H. Gilbert, a vast number of admirable field and stall experiments have been carried on since 1845, at an annual cost of some $15,000.

The laboratory and experimental grounds, with an endowment fund of £100,000 sterling, have been placed in trust by Mr. Lawes, to remain forever devoted to the investigation of agricultural science."

The laboratory of the Royal Agricultural Society of England, under the direction of Dr. Voelcker, at London. Dr. Voelcker receives £300 sterling salary, £200 for investigations, and fees for analyses, which number some 700 annually. This work has been going on for over twenty years.

Each one of the larger universities and agricultural academies of Germany has, among its institutions for scientific research, one or more laboratories devoted to investigations in agricultural science. In these some of the most noted of the German investigators are employed. Twelve universities and three higher agricultural schools in Russia make similar though, at present, less generous provision for agricultural research.

It was only a very brief time after Italy was freed from papal rule, and united under the liberal government of Victor Emanuel, that steps were taken toward the promotion of its most important material interests by the establishment of agricultural experiment stations on the German plan. Some thirteen are now in operation there.

Among the means adopted by the German government for pacifying and improving the condition of the province of Alsace-Lorraine, lately acquired from France, were the establishment of a university at Strasburg and an experiment station at Rufach.

Experiment Stations in the United States. — The Bussey Institution of Harvard University, though not an experiment station in name, continues to show itself, under the direction of Professor Storer, a very efficient and useful one in fact. The first volume of its Bulletin — a work of some 470 large and closely printed pages—has been completed during the past year, and gives accounts of a large amount of work, as scientific and thorough as it is unostentatious.

The last report of the Connecticut Board of Agriculture contains a "Preliminary Report" of a part of the first year's work of the Connecticut Agricultural Experiment Station, which shows that this, the first institution of the sort in this country, is commencing what promises to be a successful career. Its chief attention thus far has been given to the subject of commercial fertilizers, though investigations of more abstract questions in agricultural science are in progress.

The example of Connecticut seems to bid fair to be followed in a number of the other states of the Union. The Vermont State Board of Agriculture, with the aid of Professor Seeley, of Middlebury College, who is secretary and chemist of the Board, have undertaken the establishment of an experiment station, of which the first Bulletin has already appeared. Prominent agriculturists in a number of other states have been urging before their respective legislatures the importance of appropriations for the same purpose.

FERTILIZERS AND FERTILIZER CONTROL SYSTEMS.

Experiment Stations and the Trade in Commercial Fertilizers.—It is just about twenty-five years since in Germany, as here, the trade in superphosphates, guano, and similar commercial fertilizers, began. The same stupendous frauds by adulteration and dilution of good things were practiced there as they have been, and we have great reason to fear still are, carried on here. But the experiment station has perfectly cured and rooted out these evils in all the districts where it has been established and appreciated. The experiment station there is prepared to furnish the farmers at small cost with an analysis of any fertilizer he proposes to buy. The farmers avail themselves of this aid. They will buy no fertilizer without an exact statement of its composition, and they buy with the understanding that any deficiencies in the stipulated amount of fertilizing matters shall be made good or deducted from the payment. Under such circumstances manufacturers can sell nothing that is not substantially what it claims to be. A further result of this system is that low-grade fertilizers are little sought, and those makers who can supply the best article, of uniform quality and at the lowest rates, have the business. With large sales the dealers prosper, while the consumers are satisfied with their purchases; and, instead of trying to see how they can get along with small use of purchased fertilizers, they are studying how to use the greatest quantities to advantage. The fertilizer market in Saxony and Prussia, where the experiment station has the universal sanction and confidence of the farmers, is just as settled and satisfactory as any branch of trade, and the farmers there buy superphosphate, guano, potash salts, etc., with as much security of fair dealing as we can feel in the purchase of sugar or nails.—*Professor S. W. Johnson, in Tenth Annual Report of the Sheffield Scientific School of Yale College.*

The German Fertilizer Control System.—The plans adopted by the German experiment stations for supervising the trade in fertilizers, though somewhat various in their details, have one fundamental characteristic in common, namely, an arrangement made between the stations and dealers, whereby the latter guarantee their goods to contain certain percentages of valuable ingredients, the verification of the guarantee being left to the analysis made at the stations. Provisions are at the same time made whereby purchasers can have samples of the articles they buy analyzed at small cost or for nothing, and thus assure themselves that their purchases are as represented. In many cases the chemists of the station select samples for analysis from stocks under their supervision. The farmers have thus the fullest security that they will get the worth of their money in the fertilizers they buy.

The Connecticut Experiment Station and the Fertilizer Trade.—A fertilizer control system on the German plan has been introduced in Connecticut by the State Experiment Station, and is working very satisfactorily. A considerable number of low-grade and fraudulent fertilizers have been examined, and their character exposed. One article, for instance, which had been sold for $55 per ton, a discount from the regular price of $60 per ton being made to "introduce the article," proved to be nearly one half sand, and to have a commercial value of about $8 per ton. Several parties who had bought and tried the article, on learning the result of the analysis refused payment, a considerable sum of money being thus saved to the victims of the fraud. Arrangements are made whereby responsible dealers sell their goods under supervision of the station, guaranteeing their composition, and holding them at all times subject to examination by the station. Purchasers have also the privilege of having the fertilizers they buy analyzed at the station at small cost or for nothing. In no case thus far has any article sold under the supervision proved essentially inferior to the representations upon which it was sold. Taking both composition and price into account, the fertilizers sold under the supervision of the station have cost the farmers on the average less than one half as much as those not so sold.

Report on Commercial Fertilizers at the Vienna Exposition.—The report on commercial fertilizers, by Professor P. Collier, member of the Scientific Commission of the United States to the International Exhibition at Vienna in 1873, has appeared in the form of a pamphlet of sixty-seven pages, and is replete with interesting matter. It gives a large number of statistics concerning the trade in fertilizers in Europe and America, their sources, character, value, and cost.

This report coincides fully with the common experience in Europe and in this country in showing that there is a great deal of fraud in commercial fertilizers; that the bulk of what is in the market is good, however; and that the only method to prevent frauds, enable the farmers to make sure of getting reliable wares, and at the same time to improve the general quality of the wares as sold, rests in control systems based on chemical analysis.

SEEDS, SEED CONTROL, ETC.

Investigations of Seeds in Germany.—Of the many new ways in which science has of late come to be applied to agriculture, one of the most interesting as well as most useful is in the investigation of seeds. In 1869 Dr. Nobbe, director of the agricultural experiment station at Tharand, in Saxony, commenced the study of seeds in common use in Germany, and founded the first "seed-control station." How much of good has come from this may be inferred from the fact that during the seven years that have since elapsed over 4000 sam-

ples of seeds have been examined at Tharand; that adulterations have been discovered, most ingenious in character, harmful in effect, and remarkable in amount, so much so as to work a by no means inconsiderable injury to the agriculture of the country; and that some twenty seed-control stations have been established in Germany, while others have been either founded or projected in Denmark, Austria, Hungary, Holland, Belgium, and Italy.

One of the outgrowths of Professor Nobbe's work at Tharand is his lately completed "Handbuch der Samenkunde," a volume of 642 pages, of which 390 pages are devoted to the physiology of seeds, 140 pages to the methods of determining their agricultural value, and the rest to the means of preventing frauds and other cognate topics. Some of the material of this work had been previously published in the *Landwirthschaftlichen Versuchs-Stationen*, and other German journals of agricultural science, and had indicated, what the completed work decidedly shows, that a really new science, most interesting in itself and useful in its applications, is being developed by Dr. Nobbe's researches. Aside from the valuable contributions thus made to our knowledge of the constitution and characters of seeds, and the nature and conditions of the germinative process, Dr. Nobbe has shown how different seeds may be readily distinguished from each other, how adulterations may be detected and their extent estimated, and has devised a simple and ingenious apparatus by the use of which may be determined what percentage of a given sample of seed is alive, and capable of germinating and producing vigorous plants.—*Nobbe, Handbuch der Samenkunde, Berlin*, 1876.

Adulterations of Seeds.—Some facts in this connection are cited by Professor S. W. Johnson, as follows: "It is but a very few years since attention was directed in Great Britain to the wholesale distribution of purposely adulterated seeds throughout that country, and stringent laws and severe penalties were there enacted to protect the farmer.

"There lately flourished in London establishments where the business of 'doctoring' turnip seed was prosecuted on an extensive scale. Old and worthless seeds, or the seeds of inferior kinds of turnips, were killed and colored, and used to the estimated amount of 20,000 bushels annually for adulterating the seed of those varieties most sought for by farmers. In London and on the Continent hundreds of tons of the cheap yellow clover seed (*Medicago lupulina*) were and still are mixed in larger or smaller proportions with the red clover seed, and sold at the high price of the latter.

"In 1868 three tons of so-called red clover seed were sold to farmers in the Saxon city of Chemnitz alone, of which two thirds was yellow clover. In Saxony light and inferior kinds of oats are extensively bought by seedsmen to adulterate the heavy and prized sorts.

The celebrated 'Probstei rye' is annually produced to the extent of 2800 to 3400 bushels; but the amount ostensibly disposed of in the seed trade is hundreds of thousands of bushels.

"Dr. Nobbe, director of the Tharand Experiment Station, reports finding in a sample of tall meadow fescue grass (*Festicu elatior*) 70 per cent. of adulteration; and two samples of so-called 'grass seed,' having all the external appearance of a good article, were found to consist of grass flowers only, without a ripe seed of any sort.

"The climax of this kind of ingenious villainy appears to have been reached in Hamburg, where there recently existed a manufactory of counterfeit clover seed, which was made from quartz sand, and with such skill as to deceive experienced judges, who have pronounced samples containing 25 per cent. of these quartz grains to be pure red clover seed.

"In a sample of Timothy seed which had the appearance of being very pure, Dr. Nobbe found about 7 per cent. of foreign seeds, in which he identified thirty-one different kinds, mostly weeds and inferior grasses; and he calculated that upon a Saxon acre (= 1.37 English acres) no less than 1,700,000 of these foreign seeds would be sown, or twenty-four upon every square foot, by using the customary quantity of this pure Timothy seed.

"Dr. Nobbe's experiments show that very many genuine commercial seeds are of inferior quality, yielding much less than the proper average of plants, probably from admixture with the fresh stock of old seed whose vitality is impaired or destroyed.

"The many complaints that are made of the poor quality of the seeds sent out by the Agricultural Department at Washington are in large degree explained by these revelations of the state of the trade in Europe.

"It is but six or seven years since Dr. Nobbe first called public attention to this subject. He has begun the publication of a book containing full descriptions and figures of all the useful and hurtful seeds that occur in commerce; and already at some twenty experiment stations farmers are able to get trustworthy examinations of seeds as to purity and vitality, and at a trifling cost."

NUTRITION OF DOMESTIC ANIMALS.

Experiments on the Feeding of Domestic Animals.—The agricultural science of the present day includes, as one of its most important branches, the investigation of the laws of the nutrition of domestic animals. Under this general subject the special one of the digestibility of fodder materials has during the last eighteen, and especially during the last ten years been studied by feeding-trials with horses, oxen, cows, sheep, goats, and swine. These digestion experiments have been made almost exclusively at the German agricultural experiment stations, where over one thousand, each occupying the la-

bor of several men for days, weeks, or even months, have already been executed, and others are continually in progress. That so enormous an amount of work should have been accomplished is explained by the fact that thirteen of the German stations, each employing from two to five chemists, are engaged in researches in animal nutrition.

Some lately reported feeding-trials with sheep, by Schulze and Märcker at the station at Weende, in Hanover, are of interest as confirming the very important deductions from previous experiments of the same class. It has been found that a certain portion of the woody fibre of plant food is digestible and nutritious, from forty to nearly seventy per cent. of the fibre in hay, clover, and straw being digested by cattle and sheep, and a smaller proportion by horses. This crude fibre consists of cellulose (which has the same composition as starch) and other materials richer in carbon. It is believed that the cellulose constitutes the digestible part of the fibre. This view finds a remarkable confirmation in experiments referred to, in which the composition of the digested portion of the fibre coincided almost exactly with that of cellulose. Results identical with this have been found in numerous other experiments at Weende and elsewhere.—*Journal für Landwirthschaft*, 1875, s. 141.

Effect of Albuminoids and Carbohydrates upon Digestion.—It is a familiar fact that all ordinary fodder materials consist of water, mineral matters, and two classes of organic substances—the albuminoids (gluten, fibrin, etc.), which contain nitrogen, and the carbohydrates (sugar, starch, cellulose, etc.) and fats, which contain no nitrogen. One of the important principles brought out by the German experiments is that unless foods, especially mixed rations, contain a sufficient proportion of albuminoids, they are not economically digested. When carbohydrates, as sugar or starch, or materials rich in these, as potatoes, are fed in considerable quantities with hay and straw, less of the latter is digested than when they are fed alone. On the other hand, nitrogenous substances, as gluten and, likewise, foods rich in albuminoids, as oil-cake, cotton-seed meal, beans, pease, and bran, when fed even in considerable quantities with hay and straw, do not decrease the digestion. Thus, in the experiments of Schulze and Märcker, mentioned above, large quantities of gluten of wheat, and of bean-meal as well, caused no depression in the digestion of hay or aftermath, while the addition of starch and sugar to the ration decreased the digestion of the whole organic substance of the former by nine per cent., that of the albuminoids by fifteen per cent., and that of the crude fibre by eight per cent.

Lupines as Food for Sheep.—Quite in accordance with the above are the results of late experiments by Dr. Stohmann, director of the station at Leipsic, on lupines (seeds) as food for sheep. The lupines proved almost completely digestible, and (being highly nitrogenous)

exerted a very favorable influence upon the digestion of the hay. From twenty to thirty-nine per cent. more of the crude fibre was digested from the hay fed with lupines than from the same hay when fed alone. To the bitter taste, which renders lupines unpalatable to cattle, sheep do not seem to object. As a rich food for fattening sheep, Dr. Stohmann says that lupines rightly used can hardly be too warmly recommended.—*Mittheilungen des landw. Institutes der Universität Leipzig, Berlin*, 1876.

Effect of Potatoes and Turnips on Digestion of Hay and other Coarse Foods.—It is well known that a large number of experiments have been made within the last few years in the German stations on the influence of potatoes and turnips upon the digestion of hay and other coarse foods with which they are fed. It has been found that concentrated foods which contain little albuminoids and considerable carbohydrates (starch, sugar, etc.) decrease the digestion of coarse foods, and that this is quite true of turnips, and still more true of potatoes. This fact is shown in a remarkably decisive manner by the results of over one hundred experiments with sheep, conducted by Wolff and others during the past few years at the experiment station at Hohenheim. Wolff concludes that, as other experiments have indicated, the decrease of digestion of hay is decided by the proportion of albuminoids to carbohydrates in the whole ration; while potatoes, turnips, and other foods rich in carbohydrates, mixed with hay, decrease the digestion of the latter. If nitrogenous materials be added, the effect of the carbohydrates is counteracted.—*Landwirthschaftliche Versuchs-Stationen*, 1876, XIX., s. 35.

Influence of Fats upon Digestion.—Dr. Wolff has reported some experiments upon the much-discussed subject of the influence of the fats and oils of food upon digestion. Four full-grown wethers were fed, in each of several experiments, with hay to which were added, in the individual trials, concentrated foods, in some cases nearly free from oils, and in others containing more or less fatty or oily substance. Bran meal, palm-oil cake, with varying quantities of oil, were the substances employed. Wolff concludes from these experiments that the fat in nitrogenous foods causes no alteration in the digestibility of the albuminoids, unless, as is apt to be the case when an excess of oily substance is fed, a disturbance of the digestion is thereby brought about. —*Landwirthschaftliche Versuchs-Stationen*, 1876, XIX., s. 49.

Influence of Salt upon Digestion.—Weiske and assistants have experimented upon the influence of salt upon the digestion of fodder by sheep. In the first of four periods, no salt; in the second, five grammes (about one sixth of an ounce) per head per day; in the third, ten grammes; and in the fourth, none was given with the food, the latter consisting of hay, straw, and barley. No essential variation in the digestion of either albuminoids, crude fibre, or other car-

bohydrates was observed in the different periods. The authors conclude that salt is without influence upon the digestion of these ingredients in the food. On the other hand, the digestion of the mineral substances increased with the addition of the salt.—*Journal für Landwirthschaft*, 1874, XXII., s. 371–396.

Influence of Shearing on Digestion in Sheep.—It is a matter of common experience that sheep fatten better after shearing than when carrying a full coat of wool. To test the question whether this is due to a better digestion of food has been the object of some experiments by Weiske and his assistants at Proskau, in Germany. The sheep experimented upon were found to digest no more of their food after shearing than before. They consumed much less water, however, when shorn, and excreted somewhat less in the excrement and urine, and very considerably less in respiration and perspiration. The appetite was also much improved, and to this the better results in the fattening of shorn sheep are probably due.—*Journal für Landwirthschaft*, 1875, XXIII., s. 306–316.

Influence of Arsenic on Digestion of Food by Sheep.—The above-mentioned experimenters have also reported results of experiments on the influence of small doses of arsenic upon the digestion of food by sheep. The feeding of twenty milligrammes (about one eighth gramme) of arsenious acid (white arsenic) per head daily increased both the digestion and the accumulation of flesh in slight degree.—*Journal für Landwirthschaft*, 1875, XXIII., s. 317–322.

Action of Cold upon Milk.—Professor Maurice Perkins, of Union College, translates for the *Country Gentleman*, from the Paris *Comptes-Rendus*, an abstract from a paper by Eug. Tisserand, which gives some statements that are of interest in connection with the discussions now going on here with regard to the Hardin and other systems of setting milk for cream.

Numerous experiments have been made by exposing milk to different temperatures varying from 32° Fahr. to 100° Fahr., and the following facts have been elicited:

1. The rise of the cream is the more rapid as the temperature to which the milk is exposed approaches 32°.

2. The volume of the cream is greater when the milk has been efficiently cooled.

3. The yield of the butter is also greater when the milk has been exposed to a very low temperature.

4. Finally, the skimmed milk, the butter and cheese, are of better quality when prepared under the above circumstances.

While it is impossible to offer a satisfactory explanation as to the reason why artificial cold should produce a beneficial effect upon the yield and quality of the products derived from milk, it is probable that it may tend to arrest that fermentative decomposition which

is so prone to set in with organic fluids, and thus, by preventing incipient alteration, indirectly to improve the quality of the material.

The practice of warming the dairy in winter-time, so as to maintain its atmosphere at a constant temperature of about 60°, is therefore objectionable; the pans should stand in running water at as low a temperature as can be practically obtained.

It is further suggested that the foregoing facts should be brought prominently before the notice of those who are engaged in the manufacture of dairy products, in order that the many erroneous notions on this subject may be gradually eliminated.—*Country Gentleman, November* 23, 1875.

RELATIONS OF CONSTITUENTS OF SOIL AND AIR TO PLANT-GROWTH.

Rendering Mineral Phosphates Soluble by Composting and Treating with Chemicals.—Some interesting experiments on the effects of composting in rendering soluble the phosphoric acid of mineral phosphates have been made by Holdefleiss at the experiment station at Halle, Germany. Lahn phosphorite, containing 28.86 per cent. of phosphoric acid and 4.83 per cent. insoluble matters, was composted with peat, earth, urine, dung, salts of ammonia and of potash, separately and mixed in various ways. The general plan of the experiments consisted in mixing certain quantities of phosphorite with weighed portions of earth or horse-manure, putting the mixture in boxes, adding, in some cases, sulphate of ammonia, potash salts, or carbonate of lime, and keeping each moistened with either water or urine from the last of May until the fourth of the following January. The total dry substance, total phosphoric acid, and phosphoric acid soluble in citrate of ammonia, were determined in each case at the beginning and at the end of the experiment. Sixteen different mixtures, in as many boxes, were tested. In every case except one there was a slight increase of soluble phosphoric acid, but in none was this increase sufficient to be of practical moment.

In a previous series of similar experiments nearly fifty per cent. of the phosphoric acid of a phosphorite mixed with peat was rendered soluble. The explanation of this variation was found in the fact that the peat of the first trial contained sulphur, which by oxidation produced sulphuric acid, which in its turn rendered the phosphoric acid of the phosphate soluble.

From these very carefully conducted experiments it seems that there can be very little practical utility in the attempt to render mineral phosphates more available as fertilizers by composting. They would, of course, be still slower in becoming soluble when applied directly to the soil. These investigations coincide with general experience in indicating that mineral phosphates, however finely ground, can not be of much value except when treated with acid.

It would seem at first thought that the object might be attained by using peat rich in sulphur or sulphur compounds, as iron pyrites; but a result of the oxidation of iron sulphide would be the formation of protosulphate of iron, which would be injurious to vegetation.—*Zeitschrift des landwirthschaftlichen Central-Vereins der Provinz Sachsen*, 1876, I., s. 11.

Oxidation of Nitrogen in its Compounds in the Soil.—The experiments above described had a further and more important object. One of the most weighty questions which agricultural chemistry has yet to solve is that of the changes which nitrogenous compounds undergo in the soil. One part of the problem is the effect which various substances exert upon the oxidation of nitrogen in its compounds. To gain some new light on this subject, determinations were made of total nitrogen, nitric acid, and ammonia in each mixture at the beginning and at the end of the experiment. In general the nitrogen of the organic compounds evinced a very marked tendency to become oxidized to nitric acid, stronger than has been previously noticed, from one half to two thirds of the whole nitrogen being in some cases oxidized. The nitrification was directly proportional to the amount of carbonate of lime present. The nitrogen of the ammonia salts became oxidized with extreme slowness, but was still oxidized to some extent in presence of carbonate of lime. Potash salts prevented nitrification completely. It is suggested that the failure of ammonia salts as manures in soils poor in lime may be owing to the slow oxidation of the ammonia to nitric acid, and that the poor effects sometimes observed with potash salts may in some cases be due to their hindering the nitrification of nitrogenous organic materials in the soil.—*Zeitschrift des landw. Central-Vereins der Provinz Sachsen*, 1876, I., s. 14.

Nitrification Experiments by Boussingault.—Of interest in this connection are some experiments on the same subject lately reported by Boussingault, whose varied researches on the nitrogen of the atmosphere and soil in its relation to the nourishment of plants are already classic. The especial object of these last experiments was to test and compare the effects of sand and lime (as carbonate), each by itself, with that of a soil (loam), upon the formation of nitric acid from the nitrogen of organic substances of animal origin used as manure. Neither sand nor lime seemed by itself to favor especially the formation of nitric acid, while a "sandy-clayey" soil, with only 0.02 per cent. of lime, promoted the oxidation of nitrogen very decidedly.—*Comptes-Rendus*, 1876, LXXXII., 477–479.

At first sight, the results of Boussingault's experiments would seem to be quite at variance with those of Holdefleiss, and with the common belief that lime in soils favors nitrification; but it will be observed that Boussingault's results refer to lime when used alone, as carbonate of lime, while Holdefleiss worked with soils containing

lime, that is, under circumstances which approach more nearly to those which actually exist in cultivated soils.

The Assimilation of Atmospheric Nitrogen and the Absorption of Ammonia by the Soil.—The much-vexed question as to whether the soil has the power of assimilating free nitrogen is still in dispute. Simon and Dehérain claim to have proved the absorption of free nitrogen by organic compounds; but Boussingault, in a long-continued experiment, found a loss rather than gain of nitrogen in the soil, and Schloessing, on repeating Dehérain's experiments, fails to find any such absorption of nitrogen as the latter investigator reported. Schloessing has made several series of experiments on the absorption of ammonia by soils. In one series he passed air over a trough containing three hectoliters of soil, determining the amount of ammonia in the air before and after contact with the soil. There was a considerable loss of ammonia, indicating that some had been absorbed.

In two other series of experiments small portions of soil were exposed to the action of the air. In each parallel trials were made, the soil in one being in open air and kept moist, while that in the other was covered and dry. In all cases ammonia was absorbed, and in part oxidized to nitric acid. The oxidation was, however, much greater in the moist than in the dry soil. These experiments, therefore, confirm the generally accepted view that soils absorb ammonia from the air and transform it into nitric acid.—*Comptes-Rendus*, LXXXII., 1105–1108, 1202–1204.

Absorption of Free Nitrogen of the Air by Organic Compounds.—Berthelot has shown that free nitrogen is absorbed by organic compounds at the ordinary temperature under the influence of the silent electrical discharge. Benzene, oil of turpentine, marsh gas, acetylene, and moistened filter-paper absorbed nitrogen, producing compounds all of which evolved ammonia on being heated either alone or with soda-lime. The author suggests that similar processes may take place in nature, and that consequently plants may be able to assimilate nitrogen directly from the air. This assumption is directly opposed to the results of the best investigation upon the subject, which indicate that the free nitrogen of the air is not assimilated by plants. It would seem more probable that the absorption of free nitrogen by humus, and by soils containing humus, which Simon and Truchot claim to have observed, might be induced in the manner described by Berthelot. The experiments named are certainly valuable contributions to the solution of the much-vexed question of the assimilation of free nitrogen.—*Comptes-Rendus*, LXXXII., 1283, 1284, 1357–1360; LXXXIII., 677–682.

Ash of Hemp and Buckwheat Plants.—A quite extended chemical examination of the ashes of the hemp and buckwheat plants is re-

ported by Dr. Peters, chemist to the Geological Survey of Kentucky. Analyses are given of five samples of the whole hemp plant, of samples of leaves, stems, and roots separately, of the dew-rotted plants, and of hemp fibre and hemp herds. Two samples of buckwheat plants were analyzed. The results, with some practical conclusions which the author feels warranted in making, are given in a pamphlet of twenty-five pages, taken from a report of the Geological Survey. The analyses make a valuable addition to our knowledge of the composition of these plants. Only the analyses of the ash are given, however, no mention being made of the nitrogen, an omission which, if supplied, would add very materially to the completeness and value of the work. — *Geological Survey of Kentucky*, Part III., Vol. II., Second Series.

INDUSTRIAL STATISTICS.

By WILLIAM H. WAHL.

IRON AND STEEL.

The same remarks with which we introduced our *résumé* of the condition of the *Iron* producing and manufacturing industries of the country in last year's *Record* will apply with equal force to our present statement. These were, in brief, that, though presenting certain favorable features, the condition of these industries was much the same as at the close of the previous year. An inspection of the accompanying statistical tables will afford the reader an oversight of this field of industry, brought down to as recent a date as the returns at our command will permit.

From the annual report of the secretary of the association, it is announced that the production of pig-iron in 1875 was 2,266,581 net tons, against 2,689,413 tons in 1874, 2,868,278 tons in 1873, and 2,854,558 tons in 1872. A comparison of these figures shows a decrease of production in 1875, as compared with that of 1874, of 422,832 tons, or more than 15 per cent. The actual production of 1875, as ascertained, is somewhat larger than our estimate published in last year's *Record*. Of the total pig-iron product of 1875, 908,046 tons were anthracite, 947,545 tons were bituminous coal and coke, and 410,990 tons were charcoal iron.

The number of completed furnace stacks at the close of 1875, not including abandoned stacks, was 713, against 693 at the close of 1874, and 657 at the close of 1873. During the year 1875, therefore, 20 stacks were added to the productive capacity of the country. Of these 713 furnaces, at the close of 1875, 293 were in blast, and 420 were out of blast.

Of the total production for 1875, it appears, on further analysis, Pennsylvania made 42.4 per cent.; Ohio, 18.3; New York, 11.7; Michigan, 5; New Jersey, 2.8; Wisconsin, 2.7; Missouri, 2.6; Illinois, 2.2; Kentucky, 2.1; and the remaining iron-making states each less than 2 per cent.

The following table shows the production of pig-iron (of all kinds) for the years 1872, 1873, 1874, and 1875, arranged by states, based upon statistics collected from the manufacturers by the American Iron and Steel Association:

States.	Whole No. completed Stacks, Dec. 31, 1872.	Whole No. completed Stacks, Dec. 31, 1874.	Whole No. completed Stacks, Dec. 31, 1876.	No. of Stacks in Blast, Dec. 31, 1876.	No. of Stacks out of Blast, Dec. 31, 1876.	Make of Pig-iron in 1872. Net Tons.	Make of Pig-iron in 1873. Net Tons.	Make of Pig-iron in 1874. Net Tons.	Make of Pig-iron in 1875. Net Tons.
Maine........	1	1	1	1	..	....	780	1,661	2,046
Vermont.....	2	2	2	..	2	2,000	[illegible]00	3,450	2,400
Mass.........	6	6	6	4	2	17,670	[illegible]56	27,991	21,285
Connecticut..	10	10	10	5	5	22,709	[illegible]77	14,518	16,960
New York....	62	58	57	26	31	391,165	[illegible]18	326,731	266,431
New Jersey..	16	17	18	6	12	103,808	[illegible]41	90,150	64,069
Pennsylvania	269	266	278	118	160	1,401,497	1,[illegible]73	1,215,153	960,584
Maryland...	23	23	24	7	17	66,081	[illegible]56	54,656	58,741
Virginia......	35	38	34	8	26	21,445	[illegible]75	29,461	29,995
N. Carolina..	8	8	8	..	8	1,073	[illegible]88	1,340	900
Georgia......	8	10	12	5	7	2,945	[illegible]01	9,736	16,509
Alabama.....	11	14	14	6	8	12,519	[illegible]39	32,863	25,193
Texas........	1	1	1	..	1	619	[illegible]90	1,012	....
W. Virginia..	6	9	12	4	8	20,796	[illegible]56	30,184	25,277
Kentucky....	25	27	28	8	15	67,896	[illegible]90	61,227	48,889
Tennessee...	20	22	22	7	15	42,454	[illegible]14	48,770	36,811
Ohio..........	88	93	100	54	46	399,748	[illegible]89	495,001	415,893
Indiana......	8	8	9	4	5	32,221	[illegible]56	18,732	22,061
Illinois	10	10	12	3	9	78,637	[illegible]96	87,946	49,762
Michigan....	23	24	24	14	10	100,222	[illegible]96	136,602	114,906
Wisconsin...	10	14	14	6	8	65,086	[illegible]48	50,792	62,189
Missouri.....	18	19	19	6	13	101,153	[illegible]68	75,817	59,717
Oregon......	1	1	1	1	..	....	....	2,500	1,000
Utah.........	..	1	1	..	1	....	....	200	150
Minnesota...	..	1	1	..	1	....	....	....	....
Total......	657	693	713	296	420	2,854,558	2,868,278	2,689,413	2,266,581

A recapitulation of the foregoing statistics, showing the relative proportions of the various kinds of pig-iron, and the magnitude of the several branches of the industry, is given below:

Kinds of Pig-iron.	Whole No. completed Stacks, Dec. 31, 1872.	Whole No. completed Stacks, Dec. 31, 1874.	Whole No. completed Stacks, Dec. 31, 1876.	No. of Stacks in Blast, Dec. 31, 1876.	No. of Stacks out of Blast, Dec. 31, 1876.	Make of Pig-iron in 1872. Net Tons.	Make of Pig-iron in 1873. Net Tons.	Make of Pig-iron in 1874. Net Tons.	Make of Pig-iron in 1875. Net Tons.
Anthracite...	[illegible]	217	235	190	125	1,369,812	1,312,754	1,202,144	908,046
Charcoal.....	279	295	281	95	186	500,587	577,620	576,557	410,990
Bituminous Coal and Coke	171	181	207	89	109	984,159	977,904	910,712	947,545
Total....	657	693	713	296	420	2,854,558	2,868,278	2,689,413	2,266,581

The New York *Iron Age* has published a valuable statistical report, showing in detail the condition of the blast furnaces of the country on September 1st, 1876, which enables us to draw the inference that the production of the year just past will show a considerable decrease as compared with 1875. The journal in question affirms that the reports it publishes are nearly complete. One of the notable facts shown by the report is that a much larger proportion of furnaces are out of blast than at corresponding dates of 1874 and 1875. The following table shows comparatively the results of reports made to the journal referred to during the last three years:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
Charcoal..........	143	109	70	63	161	152
Anthracite........	122	86	70	65	121	155
Bituminous.......	83	89	76	98	107	133

Percentage in and out of blast of whole number reporting:

Fuel.	In Blast.			Out of Blast.		
	1874.	1875.	1876.	1874.	1875.	1876.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Charcoal..........	69	40	32	31	60	68
Anthracite........	61	42	31	39	58	69
Bituminous.......	46	45	36	54	55	64

The following gives a comprehensive summary of the condition of things:

Fuel.	Total No. of completed Stacks.	No. of Stacks Reporting.	No. of Stacks in Blast.	Weekly Capacity, in Gross Tons, of the Stacks in Blast.	No. of Stacks out of Blast.	Weekly Capacity, in Gross Tons, of the Stacks out of Blast.
Charcoal............	285	222	70	6,797	152	12,009
Anthracite...........	225	225	70	13,790	155	28,605
Bituminous.........	209	209	76	18,675	133	27,065
Total............	719	656	216	39,262	440	67,679

Following the published statistics of the association, we are enabled to affirm that the total production of rolled iron in 1875 was 1,890,379 net tons, against 1,839,560 tons in 1874, and 1,966,445 tons in 1873. These figures embrace all kinds of rails, including Bessemer cut nails and spikes, bar, band, hoop, plate, sheet, angle, girder, beam, boat, guide, rod and bridge iron, and rolled axles, and are exclusive of forged iron, such as anchors, anvils, hammered axles, cranks, ships' knees, etc.

The total production of iron and steel rails of all sizes in 1875 was 792,512 net tons, against 729,413 tons in 1874, 890,077 in 1873, and 1,000,000 in 1872. Of this total for 1875, 501,649 tons were iron rails (against 584,469 tons in 1874), and 290,863 tons were Bessemer steel rails (against 144,944 tons in 1874). The increase in the production of Bessemer rails during the year 1875 was therefore more than 100 per cent. over the production of 1874. The increase in the quantity of street rails produced was also noteworthy, the product of 1875 being 16,340 tons, as compared with 6,739 tons in 1874.

There were during the year 1875 ten completed Bessemer establishments in this country in more or less active operation. Two of

these, the Edgar Thompson and the Lackawanna, were started in that year, as noticed in our last year's *Record*. During the year 1876 one new establishment, the Vulcan, at St. Louis, which made its first blow in the month of July, was added to the list, making the total number of Bessemer works in the country eleven. The following table of Bessemer rail production, drawn from the association's statistics, completes our annual *résumé* of this important branch of the iron industry up to January 1st, 1876:

	Net Tons.		Net Tons.
1867 (ascertained)............	2,550	1872 (ascertained)...........	94,070
1868 "	7,225	1873 "	129,015
1869 "	9,650	1874 "	144,944
1870 "	34,000	1875 "	290,863
1871 "	38,250		

As will be observed, by the inspection of our last year's comments, the secretary's estimate for 1875 was somewhat below the mark. The use of Bessemer steel for general purposes is rapidly increasing. The total quantity of pig-iron (including spiegeleisen) converted by the pneumatic process in 1875 was 395,956 net tons, as compared with 204,352 tons in 1874, and 188,534 tons in 1873. Not less than one sixth of our total production of pig-iron in 1875 was converted into Bessemer steel; and so active is this industry that a notable increase may be expected for the year 1876. Some 33,245 tons of spiegeleisen were used in the Bessemer establishments of the country in 1875, of which 7832 tons were produced in the United States. No new spiegeleisen furnaces went into operation during the year 1876.

The details of the domestic Bessemer industry appear in the following tabular statement:

	1874.	1875.
Tons of pig-iron and spiegel converted.......	204,352	395,956
Tons of ingots produced.....................	191,933	375,517
Tons of rails produced......................	144,944	290,863

Great Britain's product of Bessemer steel ingots during the year 1875 was 592,000 tons, as compared with 540,000 tons in 1874. An inspection of the table of domestic production given above will show that the rate of increase in this country is far greater than in Great Britain.

The aggregate product of the fifty-four establishments in this country making steel other than Bessemer was for the year 1875 61,058 net tons, as compared with 49,681 tons for 1874. Of this total, 39,401 tons were crucible steel, and 21,657 tons were puddled, blister, and open-hearth steel. The association publishes the following table, showing the production of steel (other than Bessemer) by states during the year 1875 in net tons:

States.	Crucible Steel.	Puddled, Open-hearth, and Blister Steel.	Total.
New England	1,620	4,510	6,130
New York	2,300	....	2,300
New Jersey	7,098	160	7,258
Pennsylvania	26,615	11,520	38,135
Maryland and Georgia	268	1,500	1,768
Ohio	1,300	3,667	4,967
Kentucky and Illinois	200	300	500
Total	39,401	21,657	61,058

The production of open-hearth, or Siemens-Martin steel, as noted in our last year's report, shows a steady increase, the production for 1875 being 9050 tons, as compared with 7000 tons in 1874, 3500 in 1873, and 3000 in 1872. The secretary of the association reports that the product of 1875 was made by twelve establishments.

The accompanying memorandum of the Siemens furnaces built and in course of construction during the year 1876 to date of writing is given on the authority of Dr. Siemens' American agents, Messrs. Richmond & Potts:

Iron and steel melting-furnaces of various capacities, from 15 to 50 tons in 24 hours	39	furnaces.
Open-hearth steel-melting for the manufacture of homogeneous iron or steel upon the open hearth	4	"
Double puddling-furnaces	12	"
Crucible-steel melting-furnaces of 54 pots' capacity	2	"
Spiegel melting-furnaces for the manufacture of spiegel	2	"
Total	59	"

The same authority places the product of the forges and bloomaries in the country in 1875 at 49,243 tons, as compared with 61,670 tons in 1874.

The following, then, are the leading facts in connection with the number, capacity, and character of the iron and steel establishments of the country, as gleaned from the association's tables, bringing the record up to January 1st, 1876:

Whole number of blast furnaces, excluding abandoned furnaces, January 1st, 1876	713
Annual capacity of all the 713 furnaces, in net tons	5,439,230
Whole number of rolling-mills, January 1st, 1876	332
Whole number of single puddling-furnaces (double furnaces counting as two)	4,475
Total annual capacity of all rolling-mills in finished iron, net tons	4,189,760
Annual capacity of all the rail-mills in heavy rails, net tons	1,940,300
Number of Bessemer steel-works, January 1st, 1876	11
Annual capacity in ingots, net tons	500,000
Number of Bessemer converters	24
Number of open-hearth steel-works, January 1st, 1876	22
Annual capacity in ingots, net tons	45,000

Number of crucible, German, blister, and puddled steel-works, January 1st, 1876	39
Annual capacity of merchantable steel, net tons	108,250
Of which there were of crucible steel, in net tons	45,000
Number of forges making blooms direct from the ore, January 1st, 1876	39
Annual capacity in blooms and billets, net tons	59,450
Number of bloomaries, January 1st, 1876, making blooms from pig-iron	59
Annual capacity in blooms, net tons	60,200

We add, in conclusion, the following table, presenting a summary of the production of the various branches of the iron and steel industries of the country, completing the similar table in our last year's *Record* up to January 1st, 1876:

Products.	1873.	1874.	1875.
	Net Tons.	Net Tons.	Net Tons.
Pig-iron	2,868,278	2,689,413	2,266,581
All-rolled-iron, including rails	1,966,445	1,839,560	1,890,379
All-rolled-iron, excluding rails	1,076,368	1,110,174	1,097,867
Rails of all kinds	890,077	729,418	792,512
Bessemer steel rails	129,015	144,944	290,863
Iron and all other rails	761,062	584,469	501,649
Steel rails, included in iron rails	9,430	6,739	16,340
Kegs of cut nails and spikes	4,024,704	4,912,180	4,726,881
Merchantable Bessemer steel other than rails	27,985	31,635	84,654
Total Bessemer steel	157,000	176,579	375,517
Crucible cast steel	32,786	34,128	39,401
Open-hearth steel	3,500	7,000	9,050
All other steel	13,714	6,353	12,607
Blooms from ore and pig-iron	62,564	61,070	49,243

The total imports into the United States of iron and steel and manufactures thereof, during the fiscal year ending June 30th, 1876, were valued at $13,191,618; and the total domestic exports of these commodities for the same period at $15,175,166. The exports have therefore exceeded the imports by $1,983,548. In the list of imports of these commodities the largest items of decrease are those of rails of iron and steel.

Mr. Rothwell, editor of the *Engineering and Mining Journal*, states that the total production of anthracite coal in the United States for the year 1875 was 20,654,509 gross tons. That of bituminous coal the same authority places at 26,858,726 gross tons. The figures for the year 1876 are not yet available. The production of mineral coal in Great Britain during the year 1875, as obtained from the reports of the inspectors of mines for that year, was 149,303,263 net tons.*

* The secretary of the association estimates the pig-iron production for 1876 to have been 2,050,000 net tons; and Mr. Rothwell estimates the production of coal of all kinds in the United States during 1876 to have been 45,500,000 gross tons.

From the most authentic sources of information at our command, we are enabled to make the statement that, from the date of the first discovery of gold in California down to the close of the year 1875, the total amount of gold and silver produced in the United States was as follows:

	Troy Ounces.	Value.
Gold	66,680,000	$1,332,700,000
Silver	201,300,000	261,450,000
Total	267,980,000	$1,594,150,000

It may not be out of place to interpolate here the following figures, prepared by Prof. R. W. Raymond, showing the production of the leading metals, minerals, etc., during the first century of the Republic:

Coal, anthracite (tons of 2240 lbs.)	341,521,423
Pig-iron " " "	40,000,000
Lead " " "	855,000
Copper " " "	200,000
Quicksilver, in flasks of 76½ lbs	840,000
Petroleum, bbls. of 42 gallons	76,594,600

From the published statements of the Chief of the Bureau of Statistics we present the following details, showing the quantities and values of articles imported into and exported from the United States during the fiscal year ending June 30th, 1876:

MERCHANDISE.

Exports, domestic (gold value)	$525,582,247
Exports, foreign "	14,802,424
	$540,384,671
Imports	460,741,190
Excess of exports over imports	$79,643,481

SPECIE AND BULLION.

Exports	$56,506,302
Imports	15,936,681
Excess of exports over imports	$40,569,621

A comparison of these figures with those of the year immediately preceding shows that we exported thirty millions less specie and bullion in the last than in the preceding year; and that our exports of merchandise exceeded our imports by nearly eighty millions, the balance of trade being more in our favor than for many years.

To supplement the above, we may append, in conclusion, the following facts concerning our internal commerce, as gleaned from Poor's *Railroad Manual* for 1876. It appears from this very reliable work that the tonnage of all the railroads in the United States during the past year was not less than 200,000,000 tons, having increased fortyfold during the past twenty-five years; at $50 per ton,

the value would be $10,000,000,000. The canals of the country transported not less than 10,000,000 tons, worth $500,000,000. The tonnage of vessels employed in the domestic trade of the United States is 4,000,000; which, estimating four voyages per year and light freights, may be placed at 15,000,000 tons per annum, having a minimum value of $750,000,000. From the above there results the grand total of $11,250,000,000 per annum as the volume of the internal commerce of the United States—an amount nearly ten times as great as the value of our exports and imports combined.

INTERNATIONAL EXHIBITION OF 1876.

The Centennial Exhibition has passed into history, and although in a work of this nature it is obviously no part of our task to attempt the depiction of the magnificence and profusion of the works of human genius and ingenuity there displayed, and which have doubtless delighted the eyes and amazed and bewildered the understanding of most of our readers, we may properly devote a little space to a few comments upon its industrial results, relegating to our miscellaneous columns such descriptive items of the multitude of exhibits as appear to be worthy of special attention by reason of pre-eminent merit or novelty.

The most permanently valuable lesson of the Exhibition has doubtless been the ocular demonstration which it has afforded to multitudes of our own people of the prodigious strides made by the United States in every description of industrial enterprise, the direct and useful result of which will manifestly be the wide dissemination of the conviction, which there is every reason to hope may become the national belief, that in every branch of manufacturing industry that has reference to the general wants of the country the productions of the United States are fully equal and in many instances superior, by reason of better adaptation to domestic demands, than similar productions of foreign countries; and the American manufacturer will doubtless in the future be spared the humiliation of seeing the products of his mills and workshops sold as of French, English, or German make, to gratify the prejudice, now happily tolerably well dissipated, of that large body of our people in whose vocabulary the designation *foreign* was at once the synonym for and the assurance of excellence. Besides this quiet but complete revolution of opinion at home respecting the excellence of home productions, it was reserved for the Exhibition, by the institution of a direct comparison between the qualities of American and foreign wares beneath the eyes of consumers, to open new markets for them, to the permanent benefit of home manufactures. The far-reaching influence of this great educator of our people has been well expressed in the following terms by one of the leading daily journals: "Related to these varied ramifications of influence, the

Centennial Exhibition means a more rapid and comprehensive development of our material resources, a steady expansion of the activities of commerce and trade, a reign of unexampled prosperity, and the realization of industrial independence; the year 1876 possessing in this last respect the same relation which the year 1776 bore to our political independence."

Prior to the close of the Exhibition, steps were taken by enterprising gentlemen interested in such a project, to avail themselves of the admirable opportunity afforded by the existence of the vast collection of industrial and artistic treasures in the Exhibition buildings to secure the largest of them—the Main building—for the purpose of instituting therein a permanent exhibition. The project, at the time of this writing, promises to be most successful. The Main building has been secured for the purpose by purchase, and it is affirmed that applications for space on the part of intending exhibitors have already reached such a number that the managers will be obliged to make selections from the mass of materials offered for display. One of the attractive features of the permanent exhibition will be the presence of most of the handsome inclosures marking the exhibits of the various nationalities represented at the Exhibition—the most imposing and characteristic of which have been donated to the permanent exhibition by the proper authorities. The scheme for the establishment of a school of industrial art, and the creation of a museum for this purpose, in the Memorial Hall, likewise bids fair to be successfully accomplished; and last, but not least, we may record that, at the instance of the Franklin Institute, the authorities of the city of Philadelphia have given their consent to the retention of the Machinery Hall for the holding of periodical exhibitions of mechanical inventions under its auspices.

RAILROADS.

A new railway route between New York and Philadelphia, popularly called the "Bound Brook Route," was completed during the past year, and formally opened for traffic on May 1st. The following details of the new line may be found of interest. The route from New York follows the Central Railroad of New Jersey to Bound Brook; thence over the Delaware and Bound Brook Railroad, through the Hopewell Valley to Yardleyville, where it crosses the Delaware River by a substantial iron bridge; and thence over the North Pennsylvania Railroad to Philadelphia. At Bound Brook the line diverges from the main line of the Central Railroad of New Jersey, and, crossing the Raritan River, runs off southwesterly in an almost direct line to the Delaware River, a distance of twenty-seven miles. The iron bridge at Yardleyville, crossing the Delaware River and the Raritan Canal feeder, is 4000 feet in length, including approaches, and was built jointly by the North Pennsylvania and

Delaware and Bound Brook Railroad Companies. The new line is eighty-eight miles long, and is affirmed to be several miles shorter than other existing routes.

The success of the Boston, Revere Beach, and Lynn Railroad, it is reported, has started into life numerous schemes for narrow-gauge roads of greater or less length to radiate from Boston in all directions, the propositions being, in brief, to build a net-work of narrow-gauge railways from Boston to many of the principal towns between that city and Worcester and Fitchburg. The difficulty of entering Boston without cost it is proposed to meet by a pile bridge over the Charles River, and a tunnel under Beach Hill, coming out on Pemberton Square, or Washington Street, near the Old South Church. One of these proposed lines, the Newton and Boston, has already been surveyed through Brighton and Newton to East Natick. Another is the Boston, Watertown, and Waltham, with a branch to Cambridge. It is also proposed to finish the Massachusetts Central as a narrow gauge to West Boyleston. Another line is proposed from the west end of the tunnel and Charles River through Brighton, Newton, Wellesley, Natick, Framingham, Ashland, Southboro and Westboro to Worcester.

From foreign sources we glean the following outlines concerning the more important projects for railway extension, in course of execution or projected during the past year. In New South Wales the Colonial government has under consideration a proposition for borrowing £3,000,000 for an extension of the existing railway system, with particular reference to a project for connecting the port of Sidney with certain extensive coal-fields within a radius of fifty miles. Surveys have been made with the view to the establishment of a railway 360 miles long in Newfoundland, at a cost of £2,500,000. In Buenos Ayres an English company has projected a road from San Nicholas to Junon, to traverse about 100 miles of well-settled country. A contract for the construction of the Caraccas railway was concluded, and the road will probably be built with French capital.

On the continent of Europe it is declared that, in spite of the prolonged depression in trade, there is more activity and vitality in railroad circles than there has been for many years. At the close of the past year there were no less than 400 miles of railway in course of construction in Italy, and several new lines in contemplation. Some 400 miles of railway are about being constructed in Portugal, the necessary concessions and surveys having been made; while no less than eight new lines were authorized by the Austrian government, and a beginning was made with the Seville and Huelva Railway in Spain, 105 kilos. in length. A line was projected from Timbuctoo to Algiers by way of Galeah and the Sahara. The Russian government is said to have given serious consideration to the construction of a European-Siberian line from Kazan to Ekaterinburg,

Yumen, and Artamovka. The official Russian geographer, in a report issued during the year, discussed various schemes for laying down roads in Siberia, and stated that none of these would be taken in hand before the completion of the European-Siberian line, 335 versts long. In France, about the close of the year, ten new lines were conceded to the South of France Railway Company, the cost of which is estimated at $17,000,000. In Belgium the government has had strong pressure brought to bear upon it, by leading iron manufacturers, to lay down new lines, and to purchase additional rolling stock for several years in advance, as a stimulus to the iron industries of the country; while in answer to similar petitions the German government decided upon the construction of several new lines. In England concessions were granted during the past year, by Parliament, for the construction of 705 miles of new railway, the estimated cost of which is given as £36,654,694. In India the construction of the important state lines, of which over 2000 miles remained to be completed at the close of 1875, was proceeded with energetically, and new railway projects for opening up that country, and bringing it into more direct communication with the mother country, were broached. Of this nature, for example, is the scheme for bringing Bombay within eight days of London by constructing a line from Scutari to Kurrachee, about 3800 miles, and another line from Antioch to Ismalia, a further distance—including branches to Damascus and Jerusalem—of 600 miles. The great Central Asian Railway, referred to in our last year's *Record*, was also revived, but nothing of special interest regarding it has transpired, save the conviction, which finds very general expression in well-informed circles, that the undertaking of this gigantic project will not be long deferred.

The present year has also witnessed the construction and opening of the first railway in China, which latter event occurred on the 30th of July. The line in question extends from Shanghai to Woosung, a distance of about ten miles. The concession for the same was obtained and the road was constructed by certain enterprising English merchants at a cost of some £30,000. It is a single line, with a gauge of two feet six inches, and is laid with a twenty-seven-pound rail of the Vignoles section on cross-sleepers. The occasion of the opening attracted a large concourse of native spectators, who evinced the liveliest interest in the proceedings. From all that can be learned of the present status of this first Chinese road, it appears to have become quite popular, and the most sanguine hopes are entertained by those interested in the opening up of the interior of the Celestial Empire by this pioneer of civilization that at last the decisive step toward the realization of their hopes has been taken.

The efficiency of the block-system of railway signals was admirably demonstrated by the scarcity of accidents on the Pennsylvania

Railroad during the progress of the Exhibition, when millions of passengers were carried over the road. This system is in operation on the New York division, and on the main line between Philadelphia and Pittsburgh. It consists, briefly described, in dividing a line of railway into sections or blocks, of such length that the movements of trains thereon can be easily controlled by telegraph operators stationed in signal-towers at the end of each block, who observe and record the movements of trains by telegraph, and who operate the signals by which the engine-drivers are directed. The apparatus of each station comprises a signal-box (rising about eighteen feet from the ground, and having sliding green and red signals, two on each side, of different colors), located near the track, so as to be easily seen by engineers of trains approaching from either direction, and the telegraphic apparatus within. By means of strong cords connecting the signals of each side with the working-room of the tower, the operator within can conveniently make the necessary changes in the signals.

The operation of the system is described as follows: Red is the stationary signal, and informs the engineer of an approaching train that he can not pass until a second signal shows that the block is clear. This information is conveyed by showing the white signal. A green signal is understood to mean that the engineer can proceed, but with caution, the block not being entirely clear of trains. The exact time at which each train reaches a station is telegraphed at once to the operators at the station just passed and the one next succeeding. The operator is thus enabled to notify the engineer of every train approaching a signal-tower with certainty of the condition of the track between the given point and the station next succeeding. The order conveyed by the danger signal is imperative, and no engineer dares to disobey it. Furthermore, no passenger train is allowed to pass a station while another train of the same class is on the block, or between the two stations, without a special order from the superintendent. Freight trains are allowed to run on a block in quick succession from two to five minutes behind each other.

TECHNOLOGY.

Mr. John E. Wootten described at one of the late meetings of the American Philosophical Society a combination of apparatus by which ordinary anthracite coal-waste, from the dirt-banks at the mines, can be profitably burned in the furnaces of stationary and locomotive boilers. The essential features of this device are described to be as follows: A closed ash-pan is provided, into which air is injected by means of a steam-jet passing through one or more tubes. Where volume of air rather than intensity is demanded, these tubes should be cylindrical; but when greater intensity is needed, as in the case of locomotives, they should be formed of two frusta of

cones, united at their smaller diameters. The mingled air and vapors pass through a perforated fire-bed into the fuel which is spread over it to the depth of about three inches. The fuel upon the grate is gently lifted by the blast from over the perforations, the finer particles floating upon the current until entirely consumed, a large proportion of the ash passing off with the draft out of the stack. To insure the rapid and complete combustion of the fuel, and prevent the formation of solid masses of clinkers, it is recommended to stir it repeatedly upon the fire-bed with a rabble-shaped instrument. This stirring process, it is declared, is an important element in the use of the fuel under consideration, inasmuch as it serves to relieve the fire from the finely divided ash, which is thus exposed to, and carried by, the draft over the bridge-wall, or through the flues of the boiler into the stack. Another important element in the system is the perforated fire-bed, the perforations in the plate being from three eighths to three fourths of an inch in diameter, and from two to three inches from centre to centre. Wrought iron is preferred as the material of the fire-bed; and its peculiar construction reduces the loss of fuel through the grate during the stirring process to a minimum, the average loss being declared to be less than two per cent. of other coal put into the furnace. A locomotive engine using coal-dirt exclusively for fuel has for some time been engaged in hauling coal trains over the Philadelphia and Reading Railroad, generating steam freely without the use of any portion of the exhaust steam as a draught-promoting agent, the substitute being a continuous supply of air and vapor, introduced into a closed ash-pit, like that described above, aided by very small jets of live steam in the chimney for the purpose of facilitating the escape of the products of combustion. The results, Mr. Wootten claims, obtained from many boilers now using the apparatus before described, show that the hitherto neglected and apparently valueless material known as coal-dirt can be profitably used for generating steam, and that hereafter it must be regarded as a fuel of great value.

While but little progress appears to have been made toward the solution of the practical difficulties of mechanical puddling during the past year, we may mention that the experiment of ore reduction in Bessemer practice appears to have been successfully accomplished at the Cruzot Works, under the direction of M. Ruduer. From the results obtained by this metallurgist the following statements and recommendations are announced: The introduction of one half ton of pure ore into a charge of seven tons of iron, toward the end of the blow, gave, in M. Ruduer's experimental trials, an excellent quality of steel, with a clear slag containing scarcely any iron. He suggests as a better method that the iron ore be packed about the sides of the converter as fettling, and the same sintered somewhat together by a small charge of coke before running in the iron. One ton of ore

to six or seven of iron may be used. The advantages claimed are: (1) Increased cheapness of the steel; (2) increased purity of the steel; (3) saving in time and fuel; (4) the possibility of using an iron poor in silica. The ore used should, however, not contain over 0.07 per cent. of phosphorus.

A process for utilizing waste iron, such as stove and machinery scrap, and the harder numbers of pig-iron, has been introduced in practice by Mr. William Batty, and is sufficiently useful and novel to warrant special mention. The essential feature of the process appears to be to recarbonize the iron, which always loses carbon when being melted in the usual way in the cupola. To neutralize the decarbonizing effects of the blast, the inventor feeds into the blast-pipe, just before it enters the tuyeres, a stream of pulverized coal (the gas-carbon which lines the retorts in the manufacture of illuminating gas being selected on account of its purity). The result is claimed to be the production of a neutral flame, which, as it contains rather an excess of carbon, the iron becomes carbonized, and therefore softer after melting than before. When the iron to be melted is very much decarbonized, Mr. Batty employs as an auxiliary a bed of charcoal in the bottom of the furnace. The inventor claims by this process to be able to melt iron-waste of every description—old castings, tin clippings, tin roofs, etc.—and produce therefrom castings of any desired quality by modifying certain details of the operation and varying its duration. He claims also to have doubled the productive capacity of the cupola, while effecting at the same time a decided economy of fuel.

The International Committee appointed by the American Institute of Mining Engineers have made a report proposing a new nomenclature for iron and steel, which, if generally adopted, will do away with much of the ambiguity which now attaches to the use of the term "steel," in consequence of its application to the products of the Bessemer, the Siemens-Martin, and other processes, which products will not harden and temper. The committee remarks, in its preamble, "Although homogeneity due to fusion is usually recognized, and is by this committee recognized as the most definitive characteristic of both hard and soft steel, this quality may be equally well expressed in other terms, thus leaving the old term 'steel' to define the malleable compounds of iron which will harden and temper." The report concludes with a resolution recommending the adoption of the following nomenclature:

I. That all malleable compounds of iron, with its ordinary ingredients, which are aggregated from pasty masses, or from piles, or from any forms of iron not in a fluid state, and which will not sensibly harden and temper, and which generally resemble what is called "wrought iron," shall be called WELD IRON (German, *Schweisseisen;* French, *fer soudé*).

II. That such compounds, when they will from any cause harden and temper, and which resemble what is now called "puddled steel," shall be called WELD STEEL (German, *Schweiss-stahl;* French, *acier soude*).

III. That all compounds of iron, with its ordinary ingredients, which have been cast from a fluid state into malleable masses, and which will not sensibly harden by being quenched in water, while at red heat, shall be called INGOT IRON (German, *Fluss-eisen;* French, *fer fondu*).

IV. That all such compounds, when they will from any cause so harden, shall be called INGOT STEEL (German, *Fluss-stahl;* French, *acier fondu*).

The report is signed by the following distinguished metallurgists: I. Lowthian Bell, P. Tunner, A. L. Holly, Dr. Hermann Wedding, Richard Akerman, Thomas Egleston, and L. Gruner.

A new alloy, which promises to prove of considerable utility in the arts, has been brought out by Mr. P. M. Parsons under the name of manganese-bronze. The addition of manganese to bronzes, it is affirmed, deoxidizes the latter; its action being strikingly visible in the texture of the metal, the grain being fine and close, and the strength greatly increased. The new alloy may be forged at a red-heat, which increases its strength and toughness. Cast test-pieces have shown an ultimate strength of twenty-four tons per square inch; and, when forged, an ultimate resistance of 30.3 tons; elastic limit, twelve tons; elongation, 20.75 per cent. These figures indicate that the new alloy possesses an ultimate strength equal to that of good wrought iron, while greatly superior to the best gun-metal, for which sixteen tons and an elastic limit of seven tons are high strengths. The effects of forging in raising the strength of the alloy are very marked. It resembles aluminium-bronze in certain respects, but possesses a much superior resistance to this alloy, which does not exceed 22.6 tons, and is also inferior to manganese-bronze in elongation and elasticity. It is claimed that the new alloy will find an application wherever gun-metal is used, while the facility with which it may be forged, and the improvement resulting therefrom, will render it even more useful for constructive uses.

Among the Centennial Exhibits of materials especially applicable for railway purposes, one of the most interesting and important was the exhibit of a variety of articles of the alloy known as phosphor-bronze. When this material was first brought out some years ago, we presented in the *Record* some of the more important of the claims of its makers, and it is quite appropriate, now that it has attained in virtue of its peculiar properties a permanently valuable position in the arts, to give a *résumé* of the applications for which it has been ascertained to possess special value. The following statements, abridged from *Iron*, the leading English metallurgical journal, will be found

to cover this subject quite fully, viz.: The superior endurance of this new alloy is bringing it rapidly into use for many other purposes besides those for which it was originally employed. It still continues in demand for bearings, but is being widely adopted with great advantage for pit-ropes, telegraph-wires, bolts, etc. When used for telegraphic purposes, it is claimed to have thrice the conductivity, and greater strength than the iron wire commonly employed. In its employment for bearings, it has been found to possess a power of endurance nearly five times greater than that of gun-metal, besides being less liable to heat. Even when heated, it is also affirmed, it does not cut the journals. In England and on the continent of Europe it has been largely introduced in the construction of the bearings of railway carriages that have to travel long distances without stopping. The gain in respect of economy is also great, showing a saving in favor of phosphor-bronze of four to one. The bearings of rolling-mill engines have to endure a similar amount of friction, and some of the largest concerns of this description in England have adopted it with satisfactory results.

Excellent results have also followed the use of phosphor-bronze for plungers, pump-cylinders, and piston-packing. When made into wire cables and ropes, it is affirmed not to be liable to take on a crystalline structure under the action of repeated shocks, which is the case with both iron and steel, as many fatal casualties testify. While it is very hard, it does not emit sparks when struck upon a harder surface, in virtue of which property it has been found to be very suitable for the tools used in the manufacture of gunpowder and the like. At the Centennial Exhibition the Phosphor-Bronze Company exhibited some fine ornamental castings, and specimens of bearings and other uses to which the metal is found applicable. The English government employs phosphor-bronze very largely in the royal arsenal gun and carriage departments. A number of the finest vessels of the English navy have likewise been fitted with phosphor-bronze bearings, slide-faces, bolts for propeller blades, slide and expansion valves, etc. Many of the Peninsular and Oriental steamships use it in their engine-fittings, and other steamship companies are adopting it for bearings, sheet-rings, slide valves and facings, piston-rod cross-head bearings, piston rings for high-pressure cylinders, etc. The authority from which we have gleaned the foregoing points concludes with the statement that a metal that can be made more ductile than copper, as tough as wrought iron, and as hard as steel, is necessarily fitted for many uses, especially as it can be remelted without any material loss or alteration in quality. In this country, finally, the use of the alloy is gradually extending.

It is worthy of note that while in this country we are just in the midst of a discussion of the feasibility of doing away with the objectionable system of carrying lines of telegraph on posts through

the crowded streets of cities, and the substitution therefor of subterranean lines, the latter system has been in successful operation in the cities of Continental Europe and in England for the past twenty years. In many instances, for example, on the Continent, there are long lines of underground telegraph extending through the country, notably the lines connecting the German fortresses; and the cable laid directly on the surface of the ground in several cases suffices to insure permanent and reliable telegraphic communication between countries situated on opposite sides of the Alps and other mountains of Europe. *Apropos* of this topic, we note the appearance of a report that a subterranean line will be laid down between the cities of Halle and Berlin, and that in the future all the German telegraphs will be underground. The advantages of the underground or cable system as compared with the aerial are obvious. It obviates, to a large extent, the numerous causes of interruption of communication resulting from the breaking of wires, whether by accident or malice, accumulations of sleet, ice, etc., or the frequent falling of poles; it largely obviates the evil of the general imperfection of insulation, so severely felt by telegraph operators during a long spell of wet weather—to say nothing of the disfigurement of the streets and highways by posts and wires, which no amount of ingenuity can make sightly or attractive. That the unsightly pole system, with its many objectionable features, which have long since practically effected its banishment as a nuisance from the cities of Europe, should still be suffered to exist in this country, which of all others has contributed more than any other to improve the art of telegraphy through the achievements of a host of ingenious inventors, is one of the puzzles of the day, and affords a conspicuous example of indifference to the introduction of a demonstrated improvement that is eminently un-American.

In the province of illumination, perhaps the most noteworthy domestic event of the past year was the successful inauguration of the Lowe water-gas process at the Manayunk Station of the Philadelphia Gas Trust. In our *Record* of last year we gave a brief description of the *modus operandi* of this very interesting process, to which we must refer our readers for details, remarking only in this place that the gist of the process is the simultaneous decomposition of steam and petroleum in the presence of incandescent carbon (anthracite), in a vertical chamber termed the generator; the fixation of the resulting mixed gases by their passage through an intensely heated mass of fire-brick, in a second chamber called the superheater; and the subsequent washing and purification of the product according to the usual methods employed in the ordinary coal gas-works. The Utica works, which up to the present year were the largest that have been erected, and which were alluded to in our summary for the year 1875, had a daily capacity of about 200,000

cubic feet, and their actual production for a number of months, until the unfortunate destruction of the works by fire, was about 120,000 cubic feet daily, representing a total production during the eight months of their existence of about 21,000,000 cubic feet. These works were so remarkably successful as to have attracted the attention of gas engineers throughout the country. They demonstrated the adaptability of the Lowe system for the production of illuminating gas of high quality and permanence upon the largest scale, and secured for the system the distinction of being the first thoroughly practical solution of the "water-gas" problem, which a generation of inventors had been vainly striving to accomplish. The establishment of a Lowe plant at Manayunk during the last year, upon a much larger scale than had previously been attempted, has afforded those who are interested in this subject a most admirable opportunity of estimating the practicability of the system, and the results achieved have been, in every essential particular, all that the most ardent champions of the innovation could have desired. The two most striking features of the system, which attract the attention of the gas engineer, are the great compactness and simplicity of the plant, and the surprising rapidity with which gas of excellent illuminating power and permanency is produced. The following statements will give an idea of the results of its practical operation. The Lowe Establishment at Manayunk was erected during the summer of 1876, and went into operation on the 4th of August. The plant consists of three generators and six superheaters. The other portions of the plant consist of the usual washing and purifying devices of the common gas-works. The generators are 10 feet 6 inches high, and have an internal diameter of 40 inches. The superheaters are 15 feet high, with an internal diameter of 34 inches. Both generators and superheaters are very solidly constructed of fire-brick, and have double walls, leaving an intervening air-space. Generators, superheaters, condenser, scrubbers, and station-meter are contained within a building 27 by 57 feet.

The old coal gas-works, which the Lowe plant just described displaces, occupied with all their necessary appurtenances about an acre and a half of ground. The retort-house (109 feet long by 33½ feet wide) was furnished with ten benches of threes, and when worked continuously to their full capacity could produce about 5000 cubic feet of gas per hour—a quantity insufficient to supply the local requirement; in consequence of which the deficiency was supplied by pumping into the holder an additional supply from the works at Market Street, several miles away. The old works required the services of thirty-four men.

The new works occupy scarcely one tenth the space of the old (the essential portions of the plant being, as before remarked, contained in a building 27 by 57 feet). Until lately they have not been

run up beyond one half their capacity, and have since the date of their going into operation been supplying, on an average, 150,000 cubic feet of 20-candle gas daily (a quantity quite sufficient to meet the local requirement), and employ the services of but seven men —three on the night shift, and four during the day. The cost of 20-candle gas delivered into the holder, inclusive of labor and interest on the investment, is admitted by the managers to be from 35 to 40 per cent. less than that of the coal gas of 16-candle power which the old works had been supplying; and this estimate will doubtless be still more favorable when the works are running up to their full capacity, and when the price of oil, which has of late been exceptionally high, returns to its normal market value. The capacity of the Manayunk plant is placed at 350,000 cubic feet daily, and the total production from August 4th to December 31st, 1876, has been 20,000,000 cubic feet. The progress that is being made in this direction will be best appreciated by the statement that during the past year the Lowe process has also been introduced at the Falls of Schuylkill and Stroudsburg, Pennsylvania, and at Clyde and Fort Plain, New York. At Kingston, Canada, Lowe works are at present in course of erection, and contracts have been effected for the building of works at the cities of Lancaster and Harrisburg, Pennsylvania; Trenton, New Jersey; Baltimore, Maryland; and Indianapolis, Indiana. The important bearing of this "water gas" system upon metallurgy and the domestic arts will appear in its proper place.

The introduction of the electric light into general use is likewise worth noticing. The experiment of applying it on shipboard appears to have been tried with satisfaction on the General Transatlantic Steamship Company's steamship *Amérique*, which has for some time been provided with one of Gramme's magneto-electric machines. The electrical signal light of the *Amérique*, when placed at the height of thirty-three feet above the water, is estimated to be visible for a distance of ten miles to an observer stationed twenty feet above the water. The advantages of the electric light are not confined, however, to lessening the risk of collision, but its powerful illuminating quality has been found extremely useful in loading and unloading, and in working the ship, and in guiding her in and out of port at night. By means of a cone of sheet-iron placed over the light, with the base of the cone uppermost, all the details of the ship's equipment are rendered visible for a considerable distance aside from the signal light. It is affirmed that the apparatus is inexpensive in operation, easily managed, and not liable to get out of order. The system of electric lighting has also, according to account, been successfully introduced at the depot of the Northern Railway in Paris, in several French industrial works, and in several Belgian coal-mines.

The use of chloride of calcium for watering the streets of large

cities has been attended with considerable success, as appears from the following abstract of a presentation of the subject before the French Academy. This salt possesses, in addition to its eminent deliquescent properties, in virtue of which it absorbs moisture with the greatest avidity, and retains it, the advantage of being excellently adapted for this use by reason of its having little or no commercial value, so that in certain localities it is looked upon as a nuisance. During the past few years the principal streets of Rome have been watered with a solution of chloride of calcium, obtained from the numerous pyroligneous acid works in its vicinity. The result is reported to be that the dampness communicated to the road, instead of disappearing in a few hours, as would be the case when water alone was used, remains for a whole week, the road continuing damp without being muddy, and presenting a hard surface, on which neither wind nor passing pedestrians nor horses have any effect. In course of time, also, the road becomes covered with a sort of crust, which increases the durability of the surface. M. Houzeau, in discussing this subject before the Academy, estimated that the use of this solution showed a saving over that of water alone of over thirty per cent. The same savant likewise attributes to this method of watering the streets certain hygienic virtues which deserve consideration, to wit: The chloride of calcium obtained from the pyroligneous acid works always contains appreciable quantities of tarry matters and perchloride of iron, the dissemination of which in the atmosphere, it is affirmed, is most salutary; while, finally, the complete suppression of dust, which is attained by this simple but efficacious remedy, must needs exert a most beneficial effect upon public health.

Professor E. W. Dory has suggested a new and, it is affirmed, very sensitive test for alcohol, which, if it realize the claims made for it, may prove to be of much practical value. The reagent employed in this case consists of a solution of molybdic acid in strong sulphuric acid. When brought into contact with this solution, a deep azure-blue coloration is brought out, if alcohol is present. This test is affirmed to be so sensitive that a quantity of alcohol as minute as the one thousand six hundred and sixty-sixth part of a grain may readily be detected. Professor Dory, in commenting upon this reaction, points out the utility of his observation by reference to the frequent substitution of alcohol for chloroform in medical compounds and mixtures, and affirms that such adulteration, which may produce the most injurious effects upon the sick, may be at once detected by this process. Should this reaction be found to be what is claimed for it, it will prove of great value in general laboratory practice.

ENGINEERING IN GENERAL.

One of the noteworthy engineering events of the past year was the successful removal of Hallett's Point Reef, one of the most formida-

ble obstructions to the navigation of New York harbor. In connection with this event, a brief summary of the operations undertaken by the national government for the improvement of New York harbor may be of interest. These operations, as gleaned from a trustworthy source, date from the year 1848, when Lieutenants Davis and Porter, U. S. N., made an examination of the narrow channel known as Hell Gate, leading from Long Island Sound to the East River. The narrow channel between Long Island and Ward's Island was rendered very dangerous by Hallett's Point Reef, that projected out into the river some three hundred feet, and caused the tide coming in from the Sound to be thrown over against an opposing rock known as the Gridiron. Besides these rocks, there were the Pot Rock, the Frying-Pan Rock, and Way's Reef, which were blasted as long ago as 1851–1852, by exploding cans of powder laid on their surface. From the above date nothing was done until the year 1866, when Major-General John Newton was assigned the duty of making an examination of the obstruction at this point, and of preparing plans and making estimates of the cost of the works necessary to remove them. The several plans submitted by this officer involved the removal of the reef at Hallett's Point, as a prominent feature, and in pursuance of these plans Congress made the first appropriation in 1869 for what have since been known as the Hell Gate improvements, assigning to General Newton the duty of carrying them out. From this time forward operations were carried on with more or less rapidity, and culminated, on the 24th of September, in the demolition of the reef by explosion. Without rehearsing details given in our last *Annual Record*, we may add the following tabular statement of the dimensions of the main headings, showing the extent of the submarine tunneling work:

Headings.	Height of Opening at the Shaft.	Width of Opening at the Shaft.	Length of Tunnel.
	Feet.	Feet.	Feet.
No. 1	22	9	296
No. 2	21	10	186
No. 3	22	11	200
No. 4	22	11	195
No. 5	20	11	191
No. 6	19	9	124
No. 7	19	11	231
No. 8	19	12	214
No. 9	17	13	226
No. 10	13	10	300

The total length of headings was 4857 feet, and of the circular galleries or cross-cuts 2568 feet, making a total of 7425 feet. The amount of rock excavated was 47,461 cubic yards, and the cubic contents of the rock in the reef above the depth of 26 feet at mean low water amounted to 51,000 cubic yards. The rock itself was an

extremely hard, foliated, hornblendic gneiss, intersected with numerous quartz veins, which rendered the progress of the tunneling work extremely difficult, and required the exercise of constant vigilance on the part of the engineers in charge of the work to avoid getting too near the bed of the river, and the shattering of the roof of rock by too heavy shots. In only one case, it is affirmed, was the roof endangered, and there a wall had to be built to support it. The explosives used in making the excavations were nitro-glycerine, several of its compounds, and common black powder. Since the year 1872 nearly all the drilling was done with the Burleigh rock-drills and the Rand drill. The diamond drill was used to some extent, principally for exploring the rock ahead of the work; but the varying hardness of the rocks and their inclination were unfavorable to it. Previous to 1872 the drilling was done by hand; and the progress of the work affords a good criterion by which to estimate the relative economy of hand and machine drilling. In this case the work of drilling was contracted for at so much per foot. Hand-drilling cost about 95 cents per foot, while the cost of drilling with the Burleigh rock-drills, including repairs, etc., was found to be, on an average, 36 to 37 cents per foot. The work of excavation was finished about the month of July, 1875, and the work of preparing for the final blast, involving the boring of holes in the pillars and roof, the charging of the same with explosives, etc., occupied a number of months. The firing of the mine was effected by electricity; and to effect the simultaneous explosion of all the holes, the conducting wires leading from the same were held on a cross-bar, forming a circuit closer; and the circuit was closed by firing a small torpedo which held the cross-bar up; when this took place, the bar fell, the brass points to which the wires were attached plunged into small cups filled with mercury, and which were connected with the second set of wires from the primers, and the circuit was closed. Every thing being in readiness, the water was let into the vast cavern, and on the afternoon of Sunday, the 24th of September, the mine was successfully exploded. The amount of disturbance caused by the explosion of the 52,206½ lbs. of dynamite, rend-rock, and Vulcan powder employed was moderate and circumscribed, and was quite a disappointment to a large body of spectators that had been attracted to the scene in the expectation of witnessing a terrific convulsion. As subsequent soundings demonstrated, however, the reef was very completely shattered, and the depth of the river considerably increased even before the removal of any of the *débris*, which eventually will all be dredged up. Until this is done the complete results of the work of demolition will not be accurately known. The work upon the Flood Rock excavations, it is understood, will now be energetically pushed forward, operations having been held in abeyance pending the consummation of the Hell Gate explosion.

During the year 1876 work upon the jetties at the South Pass of the Mississippi has been rapidly advanced, and, so far as may be inferred from what has already been accomplished, with every indication of ultimate success. The extent and location of the jetties are as follows: The lines of the jetties are 1000 feet apart. The length of the East Jetty, from the land's end to the deep water where the jetty-heads will be constructed, is about 12,500 feet. This extends out in nearly a straight line for 800 feet, and then curves to the west in order to strike more favorably the littoral current from the east which has been ascertained to exist. For most of its length this jetty is constructed on a lateral shoal where depths averaged not more than six or seven feet. At the other end it stops in thirty feet of water. The West Jetty, on account of the farther extension of the river-bank on that side, begins about 4000 feet farther down than the east one, and extends parallel to it out to the same point. At its beginning it was constructed in much deeper water than was the East Jetty, it being in fifteen feet of water, in what was the deepest channel of the bar at that point. This depth gradually shoaled to the crest of the bar, where it was from six to eight feet. The method of constructing the jetties has been fully described in our last year's *Record*, and need not, therefore, be here repeated. The improvements comprise, in addition to the building of the jetties, two other auxiliary works, namely, the closure of Grand Bayou and the construction of a dike at the head of the Pass. The purpose of these works is to deflect more water into the South Pass, and thus increase the velocity, and consequently the scouring action, of the current. Both of these auxiliary works, it is affirmed, have been completed. The following statement, given on the authority of D.W. Bowman, C.E., South Pass Jetty Works,* presents the condition of the jetties on the 26th of May last, since which time, although considerable progress has been made, no official statement of the actual condition of the work has come into our possession. This statement, although not as recent as could be desired, gives nevertheless a good idea of the rapidity with which the work under Captain Eads' superintendence is being pushed forward. At the date named the condition of the jetties was as follows: For a distance of about 11,500 feet from the land's end on East Bank the mattresses of both jetties were built up to average flood-tide, and confined nearly all the water. For about 500 feet farther the jetties were partially constructed, but did not reach the surface by several feet, the current flowing laterally over them. This work represents, at the expiration of eleven months from the commencement of operations, a total length of nearly 20,000 feet, or about four miles, exclusive of the work done at Grand Bayou

* See a complete *résumé* of this subject by this author in *Engineering News*, III., 180 *et seq.*

and the head of the Pass. Mr. Bowman, commenting upon the results already attained, predicating his statements upon the work accomplished up to the above-named date, affirms that the action of the jetties has already been sufficient to judge of their final effect, and to enable those who have staked their professional reputations upon their success to vindicate the soundness of their conclusions. Careful soundings made on the 24th of March, 1876, and compared with the official survey made before the commencement of the work, showed that 1,815,000 cubic yards of the bar had, up to that time, been removed from between the jetties. The soundings at that time (May 26th) revealed the fact that there is a channel nowhere less than twenty-two feet in depth to within 2000 feet of the deep water of the Gulf. On this remaining distance the least channel depth was seventeen feet where the original crest of the bar had been, with only nine feet of water upon it. Not the least among the favorable results is the fact that, in the deep water in advance of the jetties, instead of any indication of a re-formation of the bar, as it was predicted by the opponents of the jetty system would occur, the soundings show that, by some cause or other, the depth of water has been increased. From all published accounts, therefore, it would appear that there is no reasonable doubt, from what has already been accomplished, of the ultimate success of the Eads' jetty experiment. At the time of this writing, for example, it is reported that the channel between the jetties at average flood-tide has every where a depth of not less than twenty feet for a width of 200 feet, and that in the centre of the channel there is a minimum depth of twenty-two and a half to twenty-three feet, and a maximum depth of thirty feet. In consideration of which facts the assertion is made that vessels are now certain of having a much wider channel across the bar than has ever been offered at the Southwest Pass, where for several years dredging operations have been carried on under government direction at an annual expense of several hundred thousand dollars.

From an elaborate review of the present aspects of the Channel Tunnel project, which has lately appeared in the London *Standard*, we are enabled to glean the following facts bearing on the progress that has been made during the year just passed, viz.: The scheme in question, under Sir John Hawkshaw on the English side, and M. La Vallée on the French side, appeared more than a year ago to be making substantial progress. Three railway companies had announced their readiness to contribute their contingents of £20,000 each; and an English company had expressed its willingness to contribute the balance of the £80,000, which, according to Sir John Hawkshaw's estimates, were necessary for the trial works then in contemplation, and which were to have been at once proceeded with at St. Margaret's Bay, three or four miles to the east of Dover. The *Standard*, replying to the query as to the progress made by the En-

glish, affirms that it has amounted to less than nothing—retrogression. One of the parties interested has clung to the £80,000 trial works at Dover, involving a shaft nineteen feet in diameter, colossal pumping engines, and a submarine driftway seven feet square. Another party, in the railway interest, advocated the expenditure of a few thousands at a time for smaller trial works, to make a shaft seven or eight feet in diameter, less pumping power, and as moderate a driftway under the channel as could practically be driven. By this means, it was claimed, the requisite practical knowledge of the difficulties of the work in contemplation could be gained with the minimum of expenditure, the sum of £20,000 being named as the maximum amount for which such a shaft could be driven, and a suitable driftway carried under the sea for a distance of a third of a mile, and pumping machinery erected capable of pumping 500,000 gallons per day. The result of this conflict of opinion appears to have been that those who were depended upon to supply the funds needed for the preliminary works have either withdrawn their influence or have held aloof, and matters on the English side have, in consequence, remained practically at a dead lock.

On the French side, we are informed on the same authority, there has been a quiet and steady onward movement on a small but useful scale. The dredgings of Sir John Hawkshaw on that side of the channel were confirmed and enlarged by M. La Vallée and his staff some time ago. Since September of the year 1875 the English sea-bottom of the channel has been sounded, and additional confirmations and more precise knowledge obtained; and a boring was commenced and is just finished at Sangatte, about six or seven miles west of Calais. The official report of the French engineers upon these results has not yet appeared, but the following statements afford as complete a *résumé* thereof as can be made from extra-official sources of information. The boring was commenced at Sangatte, on the upper white chalk, at somewhat less than half its thickness; it has penetrated the lower white chalk, and has gone through about sixty-six meters of gray chalk, identical in all its distinguishing characteristics with the gray chalk on the English coast. It has further penetrated into the gault clay after passing a thin band of dark-green upper greensand; the total depth of the boring is 133 meters, and the diameter 24 centimeters. As one of the objects of these borings was to ascertain the amount of water that would be likely to be met with in the final operations, the shaft has been lined to a considerable depth with iron tubing of different diameters, let in telescopewise, the annular space between the tubes being filled in with cement, in order that the same might be consolidated and rendered water-tight. On this score the results obtained appear to have been quite favorable, the amount of infiltration being quite small, and derived, notwithstanding the proximity of the sea, from

spring water only. The borings in question have demonstrated, quite independently of the shore sections, the character and thickness of the stratum through which it is proposed to pierce the tunnel; and, further, that, notwithstanding the fact that the thicknesses of the several strata all diminish toward the French coast, they are yet of sufficient magnitude for all the engineering requirements of the contemplated improvement.

All the knowledge gained by this means, however, although it may meet the most favorable expectations of the friends of the tunnel, neither proves nor disproves the hostile theories which have long existed, and which still exist as to the occurrence of a vertical fissure along the whole median line of the English Channel, and which discussion will only be settled when the driftways of the tunnel itself are actually driven from the shores of both countries, and are about to meet midway under the bottom of the sea.

It may be well to add, in conclusion of this subject, that, should the plan of directly driving a tunnel be found impracticable, there remain several other plans of connecting France and England: one by a colossal bridge; another by a subaqueous tube laid on the bed of the channel; and a third, consisting of a platform supported on wheels, which run on rails laid on a causeway of some thirty-three feet in height, and thirteen feet in width, raised on the comparatively level bed of the channel. On this causeway it is proposed to run a vehicle 330 feet in length, 125 feet high, and composed of a pontoon at the base, and a platform above the water, united by suitable framing. The platform is to be large enough to take on board an entire railway train; and the device is to be propelled by an engine located on the platform, which, by means of a chain-belt, operates a drum, over which winds a chain that lies upon the causeway. This plan is an extension of the ideas embodied in M. Leroyer's water railway, in successful operation at St. Malo, in France.

Concerning the project of an interoceanic canal across the American isthmus, of which we gave a somewhat detailed account in our *Record* of last year, it may be remarked that, although our government has taken no steps toward carrying out the views of the commission which recommended the Nicaragua route, the subject of the canal has attracted considerable attention abroad. It was announced, for example, at a late session of the Société de Géographie, that a considerable body of gentlemen had obtained a concession from the Colombian government for the building of an interoceanic canal across the Darien Isthmus. A scientific commission, it was affirmed, would start in November to make a thorough survey of the proposed line between the Gulfs of Uboba and St. Miguel. It is furthermore affirmed that the Colombian government, at the instigation of M. Gogorza, has authorized the survey of a route by way

of the Rivers Atrato and Tuyra, which promises to be superior to any hitherto explored route.

The active interest which this subject is attracting abroad is well indicated by the fact that the Société de Géographie of Paris has established during the past year a French section of a proposed "International Committee to study the question of cutting a canal through the American isthmus," which section has entered into relations with all the geographical societies in the world of whose existence it is cognizant, begging them to co-operate in the work, and to have sections named in their respective countries similar to that in France. Finally, in connection with this subject, we may notice the current report that Mr. Henry Meiggs, the great South American contractor, has concluded a contract with the government of Nicaragua for the construction of a canal upon that route; and also that Mr. John C. Trautwine, whose name is familiar to all who are interested in the canal project, in a valuable paper upon the Darien International Canal, published in *The Polytechnic Review*, estimates the cost of the canal at this part of the isthmus at about $300,000,000, or about three times the cost of the Suez Canal. The same authority, speaking of the proposed Gogorza project of a route by way of the Rivers Atrato and Tuyra, above mentioned, says: "I have no hesitation in predicting that the survey will result in disappointment."

Another engineering project of considerable interest contemplates the cutting of a canal across the peninsula of Florida, in order to effect the junction of the Mississippi River and Atlantic Ocean. The project in question was presented at the late meeting of the International Geographical Congress, and was there most favorably commented upon. The following extracts from the several documents relating to this subject which were laid before the Congress will be read with interest: "The Associated Chambers of Commerce of the United Kingdom (affiliated now with those of Germany and France), in their recent report, after showing the enormous capabilities of the Mississippi Valley for maintaining the most flourishing trade in the world, point out among the obstructions prominently calling for removal the difficulties and expenses attending the transportation of merchandise in bond to the interior of the United States, and the excessive charges and taxes in shipping at New Orleans, which amount almost to a prohibition of the use of that port for general commerce." By no other way, it is further asserted, can these difficulties be avoided than by the adoption of the canalization scheme here alluded to. President Grant, in one of his late annual messages, says, in referring to it: "Such a route along our coast would be of great value at all times, but of inestimable value in case of foreign war. . . . Nature has already provided the greater part of the route, and the obstacles to be overcome are easily within the

skill of the engineer." The proposed route is described as follows: From New Orleans to St. Marks, in Florida, a series of lakes, lagoons, waterways, all navigable, extend along the coast, separated here and there at long intervals by low necks of land, requiring but little more than skillful dredging to open the route to the Suwanee River in Florida. From the Suwanee to the Great St. Mary's River, which from the proposed point of junction pours its stately flood unimpeded by rock or shoal into the Atlantic Ocean, near the southernmost point of Cumberland Island, the distance is only thirty miles. By this plan, and at a moderate cost (for the canal would only need to have a depth of from seven to eight feet to float the largest steamers or craft frequenting these rivers), 20,000 miles of rivers and navigable waters, already swarming with craft, and eager for commerce, will be opened up, and, to use the words of one of the enthusiastic advocates of the enterprise, "the Southern planter or the Western granger from the remotest districts will be enabled to ship their produce by the easiest and cheapest mode of transportation known to commerce, and without breaking bulk, to ocean-going steamers and shipping of any tonnage lying in the safe harbors and anchorages of the Atlantic coast, . . . thus avoiding all the dangers now incident to the navigation of the Bahamas, the reefs of Florida, and the Gulf of Mexico."

The appearance of the Annual Report of the Suez Canal Company, which was made at Paris on the 27th of June last, enables us to bring forward the statistics of this improvement to the close of the year 1875. The report affords the information that the traffic on the canal has continued steadily to increase, amounting in 1875 to 1494 ships, with an actual tonnage of 2,940,708. (For 1874 the figures were 1264 ships; tonnage, 1,681,640.) The receipts for 1875 were 30,827,194 francs; and the expenditures, including interest, 29,727,047 francs. The company declared a dividend of 1 franc 88 centimes per share.

The past year has witnessed the practical abandonment of the system of steam canal-boats, of which so much had been anticipated. The company which was the recipient of the liberal prize of the State of New York for the best system, it appears, has gone into bankruptcy; while, on the other hand, the cable-towing system—known as the Belgian system—which was specially excluded from competition for the prize, has been in successful operation on the Erie Canal during the past year between Middleport and Buffalo, a distance of forty-two miles, giving great satisfaction. The charge to boatmen is the same as for horse-power, but the speed is two or three times as great. The merits of this system have been so thoroughly tested and well established abroad that it is difficult to understand in what respects it does not realize all the desiderata that can be asked for in the application of steam to canals.

Upon the East River Suspension Bridge work has been steadily pushed forward. The Brooklyn and New York towers have both been completed as far as possible before the making and placing in position of the cables, and preparations are now well advanced for the making of the cables from which the roadway is to be suspended. At the time of this writing, two working ropes (for pulling over the cable wires), and one cradle rope (to support the wooden "cradles" used as stations by the workmen adjusting the wires), are in their places. When the making of the cables will begin depends entirely, it is said, upon the delivery of the steel wire, for which specifications and invitations for bids have been sent to all the leading manufacturers of this country and Europe. Thirty-four hundred net tons of galvanized iron wire of No. 8 Birmingham gauge, capable of sustaining a strain of 3400 pounds without breaking, will be required. It is not deemed probable that with the utmost expedition the cables will be completed within less than two years from the present time; then the building of the bridge proper, with its six gigantic iron trusses, which will be supported from the cables; its great storm-cables, which will curve across each other twice beneath the floor; its subsidiary storm-cables; its mile and one sixth of roadways, passenger ways, and railroad tracks; its long approaches with their massive piers, etc., will consume two years longer in their completion. Under the most favorable estimates, therefore, it will require four years more to complete the bridge.

Work upon the Hudson River Tunnel, the projection of which enterprise we announced in our *Record* for 1874, is about to be resumed, having been interrupted for a considerable period by litigation arising out of the opposition of the Morris and Essex Railroad Company and the Jersey Shore Improvement Company. This litigation, it is affirmed, is now at an end, having terminated in favor of the Tunnel Company. Active operations will now be commenced on the New Jersey side from the foot of Fifteenth Street. Thence the tunnel will run in a northeasterly direction, passing under the river and the Christopher Street Ferry Slip. The New York entrance, it is said, will be located in the vicinity of Washington Square. The tunnel as proposed will be about two miles in length, and will have a road-bed of twenty-three feet, with two tracks, and the entire distance will be lighted with gas. It is proposed to employ two hundred laborers, and to continue the work day and night. The capital required to complete the work according to the plans proposed is $15,000,000, of which, it is affirmed, $10,000,000 have already been obtained. It is estimated finally that the enterprise as projected will be completed within two years. The tunnel will be used for passengers, but its main object will be to afford a rapid means of transporting freight to and from the railroad depots in Jersey City.

Among the more noteworthy engineering works in contemplation,

we must not omit to mention the bridge over the Hudson River at Poughkeepsie, upon which, it is announced at the time of this writing, work will be begun at once. The contract for the building of the bridge has been awarded to the American Bridge Company of Chicago. Its estimated cost is placed at $4,000,000. The point fixed upon for the structure to cross is near the upper landing, or ferry dock, and at the intersection of the Poughkeepsie, Hartford, and Boston Railroad, and the Hudson River Railroad. The elevation of the bridge above high-water mark will be 130 feet, which will place it above the tallest masts of vessels plying the river. The entire length of the structure, with land approaches, will be 3400 feet.

From the annual report of the president of the Western Union Telegraph Company we glean the following facts concerning the pneumatic dispatch system, lately introduced by the company in New York City, viz.: During the past year the central office of the company in the city above named has been connected by means of pneumatic tubes with branch offices located at No. 14 Broad Street, No. 134 Pearl Street, and the Cotton Exchange. The tubes are of brass, each 2¼ inches internal diameter and ⅛ of an inch thick, and are laid under the pavements in the streets, at a depth of three feet. Messages are sent from the central office to the above-named branch offices by compressed air, and from the branch offices to the central stations by atmospheric pressure or exhaustion. The motive power is supplied by a 50 horse-power duplex engine, situated in the basement of the central office, which operates two double-acting air-pumps communicating with the compression and vacuum mains terminating in the operating-room. These are connected with the line of tubes by means of valves so constructed that carriers containing messages may be sent through the same in either direction by simply turning a cock connected with the compression or exhaust mains.

The usual pressure employed is six pounds to the square inch, and the time occupied in transmitting a box or carrier containing messages between the central office, corner of Broadway and Dey Street, to the office at No. 14 Broad Street (700 yards), is about 40 seconds; and between the central office and the offices at No. 134 Pearl Street and the Cotton Exchange (900 and 1100 yards respectively), about 1 minute and 5 seconds, and 1 minute and 20 seconds each.

The operation of the system is pronounced to be very satisfactory, resulting in a material saving of time and money, as compared with the old system of transmission by wire. The total cost of the improvement is placed at about $30,000, and the economy of the pneumatic system is so decided that, according to President Orton's estimates, fully one half of this outlay will be saved annually. An

extension of the pneumatic system to other branch offices in the same city, when the traffic is large enough to warrant its application, is contemplated, and, when the value of the system has been more definitely ascertained, will doubtless be carried into effect.

The London *Engineer*, commenting upon this topic, affirms in substance that the excellence in both economy and rapidity of the pneumatic over the electric telegraph, when used for sending messages over comparatively short lines, has been fully demonstrated by the experience made with the system in the cities of London, Paris, Brussels, Berlin, and other European cities; the system, wherever introduced, being constantly enlarged, while in no instance has it been abandoned. In London, we are told by the same informant, there are now twenty-four distinct tubes of an aggregate length of nearly eighteen miles; and additions are now in progress which will increase this mileage one third. In London lead is preferred for the tubes, while in Paris iron is successfully used. In point of economy, the experience with the pneumatic system in London established the fact that during the past year the expense was barely two thirds of the amount which would have been required to pay the salaries only of the clerks needed under the old wire system, irrespective of the cost of wires and instruments. The utility of the pneumatic system for the transmission of letters to and from central to branch post-offices is obvious; while its perfect solution of the problem of local transmission should make us far less tolerant of the pole nuisance in our cities than we have heretofore been.

From the English journals we learn of the proposition to extend telegraphic communication across the African continent to the Cape. There is at the present time telegraphic communication from Alexandria to Khartoum, a distance of eleven hundred miles; and surveys for its further extension into the interior have already been made. The proposed route would lead under the Victoria Nyassa and Tanganyika Lakes, and thence down the Shiré and Zambesi Rivers to the sea, where a short ocean line would connect it with Delagoa Bay or Port Natal. It is claimed, though upon what ground does not appear to be very clear, that the undertaking, if it could be established and kept in working order, would prove to be exceedingly lucrative, and also—as must be admitted—that it would aid in many ways in opening up Africa to civilization and commerce. *Apropos* of the preceding, we may add that Mr. Donald Mackenzie with a party left England in the month of July, for the purpose of testing the feasibility of that gentleman's project (mentioned in our last yearly *Record*) of flooding the Sahara. The immediate purpose of the expedition was announced to be to make the necessary surveys preliminary to the turning of the waters of the Atlantic into the great sink or basin which is believed to extend from the valley of the Bella to Timbuctoo. Mr. Mackenzie, it is said, is very confident that a canal

eight or nine miles long will suffice to accomplish the great operation of which he is the earnest advocate, and bring the mysterious negro metropolis within six or seven days' sail of the Thames. Thus far, however, no results appear to have flowed from the enterprise—the published reports all pointing to the fact that the expedition was an unsuccessful one. The question of the feasibility of the undertaking, however, does not appear to have been decided. At a recent reunion of the French Academy, however, M. de Lesseps concluded a summary of the report of Captain Roudaire upon this scheme in the following words: "We have reason to be satisfied with the results obtained by our compatriot savant; he is sure that there can be established a sea of from 25 to 40 meters in depth, and which shall cover an area of 16,000 kilometers (6200 square miles), with a length of 400 kilometers (250 miles) from east to west." Captain Roudaire estimates the cost of the work at 40,000,000 francs. Not a single oasis would be destroyed, and he claims that the revenue to be derived from the fisheries alone would pay a handsome interest on the invested capital.

From *Iron* we glean the following points concerning some extensive navigation improvements proposed for Manchester, England. The proposition in question involves the construction of a ship-canal from that city to the sea—an old project, but in a new and more practical form. Manchester is at present for customs purposes a port, but the canals connecting it with the sea *via* the Mersey are navigable only by barges. Mr. Hamilton Fulton, the originator of the present scheme, proposes to create a direct outlet for large vessels by utilizing the channel of the Irwell. This river flows through the heart of Manchester to a junction with the Mersey. The proposition is to widen the channel from Manchester to Warrington, and to excavate it to sufficient depth for vessels of 4000 tons burden. The course of the river is very sinuous, and by making straight cuts where the bends occur some nine miles in distance will be saved. From Manchester to Warrington, then, it is proposed to make use of existing waterways, widening, deepening, and straightening them, and dispensing altogether with locks. From Warrington, which is on the upper tidal portion of the Mersey, to the roadstead at Liverpool it is proposed to make a direct low-water channel, by which the ebb and flow of the tide would be kept to one course. This channel would be formed by constructing, in suitably selected positions, jetties parallel to its proposed course, so as to guide the current about the period of low tide in the desired direction. When completed, the channel would be buoyed and lighted, so that ships might pass, if necessary, at night. The scheme furthermore includes provisions for ample wharves and warehouse accommodation at Manchester and Warrington. The minimum depth of the canal at high-water neap tides is estimated at 24 feet, and the width between the quay

walls at Manchester would be 450 feet. The cost of the improvement is placed at about £3,500,000.

Another great project which is being seriously agitated in France is that of a great maritime canal between the English Channel and the Mediterranean Sea. The latest advices upon this topic assert that the delegates of chambers of commerce have formed themselves into a commission to promote its execution, and have explained the feasibility and importance of the work to various members of the national government, who have the scheme under consideration. The canal proposed is to be sufficiently large for vessels of 250 or 300 tons; and the route is by the Seine, the old Burgundy Canal, and the Rhone. It is estimated that such a route would save about 1000 miles of navigation to all heavy articles, to which class of objects it would most probably be confined. The commission, adopting the estimates of reliable engineers, place the probable cost of the work at about sixty-five million francs (about thirteen million dollars); of which amount ten million francs would have to be expended on the Lower Seine, five millions on the Upper Seine and the Yonne, ten millions on the Burgundy Canal, and forty millions on the Rhone. The depth would be thirteen and a half meters on the Rhone, and two meters elsewhere. The locks would be 133 meters by 12 meters. Transshipment would in any case be necessary only at Lyons. The works can be completed in six years, and, it is urged, will retain in France much traffic that is likely to be diverted from that country on the completion of the St. Gothard Tunnel. A project of similar import, announced by M. Manier, under the name of the "*Grand Canal du Midi*," provides for a canal the whole distance. It would be divided into five sections: 1st, from Blaye to La Reole, a distance of 80 kilometers, with an average cut of 15 meters and a width of 180 meters; 2d, from La Reole to Toulouse, 175 kilometers, with an average cut of 78.18 meters and width of 100 meters; 3d, from Toulouse to Carcassonne, 90 kilometers, with mean depth of 141.4 meters and width of 80 meters; 4th, from Carcassonne to Narbonne, 60 kilometers, with mean depth of 62 meters and width of 100 meters; and, 5th, from Narbonne to the sea, 10 kilometers, with mean depth of 12 meters and width of 180 meters. The cost of this work, however, would be so prodigious as utterly to preclude the possibility of its being seriously undertaken. The *Pall Mall Gazette* figures the expense at over £1,000,000,000.

Another important water cut-off that has attracted discussion in the leading European journals is the project of a ship-canal from Bayonne, in the Bay of Biscay, through Toulouse to Ayde, two miles from the Mediterranean. It is urged that this improvement, if constructed, would make almost a bee-line from Plymouth to Malta, and save the long run down the coasts of Portugal and Spain, which amounts to several hundred miles. The London *Times* comments

upon the project as follows: "With a ship-canal across the southern end of France, vessels could leave Liverpool, or any other English port, pass readily and quickly into the Mediterranean, and from that sea by the Suez Canal into the Arabian Sea, and thus reach our possessions in India."

Another project meriting notice is that of Mr. Henry C. Spaulding, an American engineer, who proposes to restore the ancient water-level of the Caspian Sea. He would commence the work at some point in the Caspian basin, where the surface is fifty feet below the Black Sea, and extend a level channel 500 feet in width westward, until 35 feet fall is obtained; from that point he proposes to continue the channel with a width of 150 feet, and a depth of 15 feet below the Black Sea, shoaling to 10 feet at its shore. The projector estimates that water will flow through this channel at the rate of eight miles per hour, and that with proper direction it will excavate a channel of the full size of the larger section (which shall be navigable) and fill the entire Caspian basin in about forty years. By diverting the Don into the Volga River, which could be accomplished, the projector estimates that the time of filling would be reduced to twenty-five years.

A pamphlet called the "Inter-Continental Tunnel" has lately been published in Madrid, advocating the scheme of tunneling the Strait of Gibraltar between Tarifa and Algesiras, on the Spanish coast, and Ceuta and Tangiers, on the African side. The more important points of this scheme are chronicled in our last year's *Record*.—The project of tunneling the Simplon Pass is again being mooted, a company for this purpose having been organized at Lausanne. The route of the projected work would be, it is said, from Brigue to Pelle, and its length 11.4 miles. A similar project, named in last year's *Record*, was abandoned in consequence of an unfavorable report from a commission of French engineers, who were appointed to investigate its merits.

A new ship-canal, which has long been projected for the benefit of the port of Amsterdam, was completed and thrown open to general commerce on the 21st of November, 1876. We condense the following facts relating to this work from the London *Times*: "The old route from Amsterdam to the ocean was by the Zuyder Zee, but the storms and banks of this dangerous gulf led, in 1819, to the construction of the North Holland Canal from Amsterdam to the Helder, the northernmost point of the province of North Holland, over fifty miles from Amsterdam. Why this route was chosen instead of the short cut now made is hard to understand. But provincial interests prevailed over the claims of mercantile capital, and it was reserved for our own days to bring Amsterdam, by a cut of fifteen miles, within an hour or two, at ordinary tides, of the German Ocean." The cost of this improvement is stated to have been

$10,000,000. The work of draining the Zuyder Zee, likewise, is said to be seriously contemplated by the Dutch government. This gigantic undertaking, if ever successfully completed, would reclaim some 500,000 acres of highly fertile land, and provide room for a population of 200,000 persons.

HEATING AND ILLUMINATION.

During the past year, although we may not chronicle any substantial advance in the practical application of gaseous fuel in the industries and the household, nevertheless the discussions of this most important theme, which have appeared in the several technical journals of prominence here and abroad, indicate that the problem is attracting the earnest attention of metallurgists and others. These discussions centred chiefly about the claims that have been put forward by the friends and advocates of the "water-gas process" of Lowe, the eminent value of which, we conceive, only the most progressive savans have fully appreciated. To properly comprehend the intensely practical bearing of this subject, a brief rehearsal of the causes of the enormous wastefulness of the systems of generating heat by means of coal, almost universally in vogue, will be appropriate.

The buyer of coal purchases, *ab initio*, from ten to fifteen per cent. of non-combustible and useless material, in the form of ash, with every pound of coal; while, on account of imperfections in the construction of furnaces, difficult of remedy under existing circumstances, perhaps as much as five per cent. more of combustible, in the form of dust or partially consumed fragments, passes through the grate unutilized. If even now, with so much waste as just indicated, we could really obtain all the useful effect of the remaining eighty or eighty-five per cent. of combustible, the result would be quite satisfactory; but such is far from being the case. The gasification of the coal, which is a phenomenon attending its combustion, involves the using up of a prodigious quantity of heat, the equivalent of the mechanical work performed by the particles in passing from the solid to the gaseous condition—which heat is lost so far as useful effect is concerned—being stored up in the gaseous particles insensible of thermometric measurement. The furnace gases, passing from the chimney at a temperature sometimes as high as 800° Fahrenheit, and carrying off with them immense volumes of unconsumed carbon in the form of smoke, is another material source of loss; and the introduction into the furnace of cold air and inert nitrogen, together with the absorption of heat by the furnace itself, and its conduction to surrounding objects and the atmosphere, completes the category of losses. Summing up all these items of loss, the fact that not more than fifteen to twenty per cent. of the thermal equivalent of the coal is obtained in well-constructed furnaces and steam-genera-

tors, is not at all surprising. The great and obvious advantage of gaseous over solid fuel—leaving the question of convenience out of sight—resides in the fact that the nature of the combustible permits of its instant and perfect intermixture with the air, by which a vastly more perfect combustion and the attainment of the highest possible temperature is insured—elements of the most vital importance in the majority of metallurgical and engineering operations requiring the use of fuel. These advantages find excellent illustration in the gas-furnaces of Siemens and others, which the best metallurgical authorities agree in pronouncing to be the least wasteful of all the methods heretofore devised for the consumption of fuel. In these furnaces, however, while acknowledging their eminent value, the atmospheric system of gasifying the fuel preliminary to its combustion is attended with the introduction into the furnace, and consequently into the gaseous product, of large volumes of inert nitrogen, which not only reduces the temperature of the furnace, but largely reduces the heating power of the gaseous product. The highest economy would, of course, be attained by any system by which the rapid gasification of the coal could be effected without the introduction of non-combustible diluents into the combustion-chamber. And it is just in the realization of this great desideratum of the metallurgist that the Lowe system, by which enormous volumes of heating-gas—hydrogen and carbonic oxide—are rapidly, cheaply, and continuously produced by the mutual introduction of superheated steam and incandescent carbon, claims attention.

The relation of this process to the province of illumination we have shown in another place. That we may not appear to be exaggerating its importance by dwelling upon it at too great length, we will close our discussion of the subject by a few quotations from one of the leading technical journals of the country:* "It is not of illuminating-gas, however, that we would now speak, but of heating-gas, for we are convinced that the question of the economical production of a good heating-gas once settled, the business of manufacturing it will greatly overshadow, by its enormous importance, that of making illuminating-gas. There is scarcely a use to which we apply coal in our cities that would not be benefited by the substitution of heating-gas, if the price were sufficiently low. It is said that water-gas, manufactured according to the Lowe system, can be made at a cost not to exceed fifteen cents per 1000 cubic feet, a figure which would allow of its distribution, in the enormous quantities required for domestic and manufacturing purposes, at a very low price, say, fifty cents per 1000 feet. The calorific value of this fuel calls for special attention, . . . for if water-gas, having more than four times the calorific value of Siemens' gas, can be produced here

* *Engineering and Mining Journal*, XXII., 293 et seq.

in the seaboard cities, where coal costs from four to five dollars a ton, by the Lowe or any other process at a cost of fifteen cents per 1000 feet, it must be evident that a new era in the development of industry is dawning upon us. It is not too much to expect that under these circumstances gas would take the place of coal for most uses. Its cleanliness, even if there were no great economy, would secure that result for domestic use; and the increased efficiency and convenience of gas, and the improved quality of the products obtained from it, would be sufficient to secure its adoption for manufacturing and smelting purposes. The highest economy in the use of fuel consists in supplying to the furnace, where the work is to be done, combustible gases only; . . . and since water-gas consists of carbonic oxide and hydrogen only, it seems quite evident that this is as favorable a condition in which to use a fuel as it is possible to obtain in the present state of our knowledge."

From the manifest tendency of modern utilitarianism to realize in practice the results that have been demonstrated to be possible in theory, we risk very little in the assertion that "the fuel of the future" will be gaseous; manufactured in the cities in large central establishments, distributed and "laid on" in our mills, factories, workshops, parlors, and kitchens, just as lighting-gas and water are at present supplied; and it is not exaggerating the importance of the process dwelt upon in the foregoing to affirm that it must be looked upon as having given a decided impetus to the world's progress in this direction.

INDEX TO SUMMARY.

ANNUAL RECORD

OF

SCIENCE AND INDUSTRY.

1876.

A. MATHEMATICS AND ASTRONOMY.

ON THE CISSOID OF DIOCLES.

From the inaugural dissertation of Dr. W. Böhmer, entitled "Studies upon the Cissoid of Diocles," we quote the following method of describing this curve, as given by Sir Isaac Newton:

Through the centre of a circle whose plane is vertical draw a horizontal line and a vertical one. Lay off to the left a point at a distance from the centre of twice the radius of the circle. Along the vertical line let there glide one end of a bar whose length is the diameter of the circle, and whose opposite end is fixed at right angles to a second bar of indefinite length, and which is forced always to pass through the point just found on the horizontal line. Under these conditions the centre of the first-named bar describes the cissoid required. This method of describing the curve is easily executed mechanically, and by its means we are able, as was first shown by Diocles himself, to solve the problem which so troubled the Greek geometers, viz., the construction of a cube containing exactly twice the contents of a given cube. This problem is sometimes known as the problem of Apollo, or of Delphi, since at one time, it is said, Apollo,

when standing in need of food, was ordered by the oracle of Delphi to construct an altar having double the volume of the well-known cubical golden altar of that oracle.—*Böhmer's Inaugural Dissertation*, 1874.

THEOREM IN THE EQUILIBRIUM OF FORCES.

If we have to deduce the resultant of any number whatever of forces acting upon a rigid system of points, we may begin by assuming for any given point, *n*, of the system two new forces equivalent to any other of the given forces, and which are parallel and equal to those, but have opposite directions, and therefore hold each other in equilibrium. We thus obtain successively for every pair of forces in the system an equivalent in the shape of a simple force acting at *n*, and a pair of forces which can give rise only to rotatory motion. If now the whole system of forces is to be in equilibrium, it is necessary not only that the simple forces acting at *n* shall be at equilibrium, but such equilibrium must also exist among the systems of pairs of forces tending to give rotatory motion. If equilibrium does not exist among the forces, three cases may be conceived, of which the most general is that in which both a motion of translation and a motion of rotation result from the application of these forces. In this case it is possible to replace all the assumed elementary forces by two resultants, which will not act in the same plane nor in the same direction.

This subject has been handled in an interesting inaugural dissertation by Dr. Dahmen, whence we derive the following theorems: First, an indefinite number of pairs of forces may be found, either of which will replace the original forces; and, secondly, if for each of these combinations of two inclined forces which are equivalent to each other, we connect the ends of the lines representing them, thereby constructing a tetrahedron, the solids so constructed will all have the same volume.—*Inaugural Dissertation of Dr. Dahmen*, 1874.

THE VALUE OF THE DOZEN.

As the derivation from the French *douzaine* implies, it is generally presumed that a dozen means twelve things, but in the Staffordshire potteries, and in the earthenware trade, queen's-ware in Philadelphia, crockery in other places, a doz-

en to this day represents that number of any special article which can be offered at any fixed price. That is, the price is fixed, and the number to the dozen varies. For instance, the pitchers which are called "jugs" in the trade are sold as 2, 3, 4, 6, 9, 12, 18, 24, 30, 36 pieces to each dozen, the price for a dozen being constant. The ordinary pitcher, holding a quart, is a twelve, or twelve to the dozen, while a pint pitcher is twenty-four to the dozen, and is so called when dealing in that size. Few of the articles of the trade are sold in dozens of twelve, plates being almost the only ones, and some of them are sold sixty to the dozen. Besides these curiosities in figures, the potters have peculiar names, muffins, twiflers, etc., that make up a trade language of itself. The quantities for dozens are, we think, yet preserved in the wholesale or package trade.—*Engineer*, XL., No. 1034, 281.

THE LAW OF RECIPROCITY OF PRIME NUMBERS.

In one of the letters of Legendre to Jacobi, which Borchardt has recently laid before the Berlin Academy of Sciences, it is said by Legendre, speaking of Gauss, that he is the one who, in 1801, wished to attribute to himself the discovery of the law of reciprocity published in 1785; and it is implied that to Legendre himself belongs the credit of that distinction, on account of his own memoir in 1785. In truth, however, Dr. Kronecker remarks, this theorem is due neither to Legendre nor Gauss, but to Euler, who first, although only by way of induction, arrived at that fundamental theorem, in the theory of quadratic residues, to which Legendre has given the name of the law of reciprocity. This theorem was, in fact, partially known to Euler in 1744. Legendre has, indeed, materially improved and added to what Euler had done; while to Gauss is reserved the completion of the whole work with a master's hand.—*Monatsbericht k. Akad. der Wiss., Berlin*, 1875, 267.

REUSCHEL'S TABLE OF PRIME NUMBERS.

In the April number of the monthly Bulletin of the Berlin Academy of Sciences, Kronecker gives a very full treatment of some mathematical problems, and at the close makes some remarks upon the table of complex prime numbers completed by Dr. C. G. Reuschel, and published by the Berlin Academy, from which we gather that Dr. Reuschel's

works contain in the greatest completeness, and in a well-arranged series, the principal results of some twelve years of laborious computation which the author had undertaken in order to lay a foundation for the analysis of the prime numbers by deriving them from the roots of unity on the basis of Kummer's theory. In the study of the theory of the complex numbers, the computations are so exceedingly difficult and laborious that it is scarcely possible for individual investigators to provide themselves in any special case with the necessary material of observation in order to find therein some base for theoretical investigation. Therefore the computations of Professor Reuschel have frequently proved to be valuable preliminary labors, and bring praise to the perseverance and devotion with which he has for so many years labored on his work. Unfortunately, the accidental death of Reuschel, on the 22d of May of this year, in the sixty-third year of his life, deprives him of the pleasure of reaping that benefit from his work that should naturally have been his.—*Monatsbericht k. Akad. der Wiss., Berlin*, 1875, 238.

HYPERBOLIC FUNCTIONS.

In pure mathematics, we notice the publication, in the Memoirs of the Scientific Society of Bordeaux, of an essay by Loisant on hyperbolic functions, in which he especially investigates the correlation between the co-ordinates of any point of an ellipse and any point of the hyperbola having the same axis. His investigations, which seem to have been carried out under the advice of Realis, lead apparently to numerous curious and novel mathematical relations susceptible of being practically useful in very many problems of applied mathematics.—*Mem. Sc. Soc. of Bordeaux*, 1874, 101.

CURIOUS CURVES AND EQUATIONS.

In a memoir on a certain class of transcendental curves, Professor H. A. Newton, of Yale College, states that algebraic curves have hitherto been studied more than transcendental. A few of the latter have been given in the text-books, but attempts to classify the numerous varieties of transcendental curves have been rare. From the form of a transcendental curve it is not easy to state an equation that

can represent it. The simpler inverse problem of describing the curve from the given equation is naturally the first to be undertaken. The forms that thus result may, when compared with a given new or unknown curve, suggest the form of the equation that belongs to the latter. In order to present a number of curves for future study, Professor Newton has therefore selected a single one of the numberless transcendental equations, and has in a series of twenty-five plates, embracing one hundred and fifty figures, presented a few of the very many plane curves which this one equation furnishes. Among the curves figured by him are some which reduce to a simple series of consecutive rows of isolated dots; others reduce to systems of intersecting straight lines. Other cases represent systems of screws and circles. The more complicated figures present innumerable suggestive and beautifully regular patterns, differing entirely in their characteristics from those ordinarily presented by the eccentric lathe, as applied to the ornamentation of bank-notes.—*Trans. Connecticut Academy of Sciences*, III., 97.

DÖLLEN'S METHOD OF DETERMINING LOCAL TIME.

It is well known that the method of determining the time, and consequently the longitude, by the use of the transit instrument, not in the meridian, but in the vertical of the polar star, has long been enthusiastically advocated by Döllen, and the numerous geodesists whom he has instructed at the Imperial Observatory at Poulkova. A short memoir on this subject was published by him in 1864, on the celebration of the twenty-fifth anniversary of the founding of that magnificent institution. This memoir subsequently became available to Americans through Mr. Abbe's translation published by the Hydrographic Bureau of the Navy Department. Döllen has now published a much more complete treatise, whose appearance has been delayed for various reasons, but by virtue of which delay the author states he is enabled now to say with perfect assurance that the method advocated by him has stood every test of experience, and must now be considered as the best that is known. A third memoir is promised by him on the same subject, and will be looked forward to with great interest. His confidence in the excellence of the method of determination of time in the verti-

cal of the polar star is especially based upon the experience gained in the summer of 1868, and in subsequent years. Previous to this time, in fact, the few transit instruments that had been specially adapted to his method were required for use in other places; and it was only in 1868 that some of them could be employed by the persons who were acquainted with his methods, in connection with the measurement of a degree of longitude under the sixtieth parallel of north latitude. In the fall of the same year, eight astronomical stations were occupied by his geodetic students in the neighborhood of the Duderhof mountain, near St. Petersburg, whose positions were determined in connection with the investigation of the local deviation of the pendulum.—*Döllen, Die Zeitbestimmung. Second Memoir.*

ACCURACY OF CHRONOMETERS.

An excellent investigation having been made by Lieutenant Martin, of the French navy, into the accuracy of the chronometers actually used on two voyages of circumnavigation in 1866 to 1868, he states that, first, in most cases, it is necessary to take account of the acceleration in the daily rate of the chronometer, as proportional to lapse of time. Second, that in relying upon one or two chronometers we risk the chance of doubling our errors, if we make any empirical correction for the temperature. Third, with three or more chronometers, we should make a correction for the temperature.—*Revue Maritime et Coloniale, Sept.*, 1875, 402.

ON TERRESTRIAL REFRACTION.

A series of observations has been made by Stebnitzky, colonel on the staff in the Russian army, looking to the improvement of our knowledge of terrestrial refraction. His observations were made mostly in the plains to the north of the Caucasus, and in a mountainous country. The instrument employed was a vertical circle, made by Messrs. Ertel, at Munich. The reduction of the observations and the deduction from them of some corrections to the terrestrial refraction has been made by Sawitsch. In general, he finds that the observations have been made between the epochs of tranquil images of the stars in the morning and evening; and that perhaps the terrestrial refractions thus observed

will come out smaller than the normal refraction. Some changes in the co-efficient of refraction seem to take place so suddenly that they can only be explained by supposing a derangement of the instrument. Excepting these, the remainder of the determinations merit great confidence. In general, the formulæ of Struve accord very well with these later observations made in the mountains of the Caucasus. The formula proposed by Sawitsch gives the refractions a little too great.—*Bulletin Acad. Impériale des Sciences, St. Petersburg*, 1875, 318.

CELESTIAL PHOTOMETRY.

Lindemann has investigated the merits of the method of estimating the brightness of stars as taught by Argelander, as compared with the measurements of the stellar-photometer invented by Zöllner. He has chosen to this end to make observations both with the unaided eye and with Zöllner's instrument upon the interesting variable star Algol, or Beta Persei. His observations began in 1870; but in the course of four years he was only able to secure observations of six Algol minimi suitable to his purpose. A review of his work by the eminent observer of variable stars, Schönfeld, shows that the naked-eye estimates made by Lindemann belong to the best class of work of that nature; and that his observations made by means of Zöllner's photometer can not be considered superior, and are even barely equal thereto, so far, at least, as accidental errors are concerned. With regard, however, to systematic differences in these two methods of observation, Lindemann's research yielded the most interesting conclusions, as showing that exterior influences appear to affect the instrumental observations less than those with the unaided eye; the latter make the epochs of Algol's minimum brightness come somewhat earlier than the former, but the photometric measures and the naked-eye estimations agree somewhat better after the minimum has passed than before. By comparison of his own estimates, Schönfeld finds that the diminution of brightness before the minimum is reached is, as given by him, slightly greater than that observed by Lindemann; while, on the contrary, after the minimum has passed, Schönfeld's estimates are lower than those of Lindemann. The observations of Lindemann are a con-

tribution of the highest value to our knowledge of the variability of Algol; and, as Schönfeld says, "similar works should be prosecuted the more diligently in proportion as the number of astronomers diminishes who occupy themselves with this interesting star."—*Vierteljahrsschrift der Astronomischen Gesellschaft*, X., 203.

ON THE THEORY OF THE ABERRATION OF LIGHT.

Villarceau states that he has been making a research into the theory of the aberration of light, and the influence upon it of the absolute movement of the solar system. His mathematical investigations of the subject having been concluded without regard to the methods of Gauss and Bessel, he has been independently led to conclude, in opposition to them, that the absolute movement of the solar system will have an effect other than simply to change by constant quantities the position of all stars; and he shows that in order to determine the four unknown quantities, viz., the true constant of aberration, and the three rectangular components of the movement of the solar system, it is necessary to have at least four values of the aberration by observations of four stars not situated upon the same great circle; and the observations will be best suited to the purposes in hand if they are made at two astronomical situations whose latitudes are 35½° north and south of the equator. If we would increase the accuracy of our result by increasing the number of stars, they should be distributed in groups of four, the individuals of each group being six hours apart in right ascension, and respectively 35° north and south declination. By a proper combination among the observatories at present existing in the world, it would, in fact, be possible to realize such a determination of the constant of aberration, without considerable expense, in the course of a single year.—6 *B*, LXXXI., 165.

CORRELATION OF SOLAR AND TERRESTRIAL PHENOMENA.

In some remarks on the connection between the changes that take place on the sun, and on the earth, and forming a portion of his address as President of the British Association for the Advancement of Science, Professor Balfour Stewart indulges in the following speculation: He says we are all

familiar with the generalization of Hadley, viz., that the under-currents of our atmosphere sweep along the surface of the earth from the poles to the equator, while upper currents return from the equator to the poles. These are caused by the unequal temperatures of the respective portions of the earth. They therefore have a reference, not so much to the geographical equator and poles, as to the hottest and coldest regions. These currents have both annual and daily oscillations. On the other hand, the earth is a magnet, and the existence of these general currents in our atmosphere suggests an explanation as to the origin of terrestrial magnetism. We bear in mind that rarefied air is a good conductor of electricity. The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist, rarefied air, are therefore to be regarded in the light of good conductors crossing the so-called lines of magnetic force. They therefore are the vehicle of electric currents, such as will of course react upon the magnetism of the earth; and there is, according to Stewart, a similarity between the peculiarities of the magnetic variation and the annual and daily variations of the winds, such as invites a further scrutiny. A similar parallelism exists apparently when we compare the storms in the atmosphere with the magnetic storms recorded by the needle.—*Balfour Stewart's Address at Bristol*, 1875.

CONFLICTING VIEWS OF SECCHI AND LANGLEY IN REGARD TO THE SUN.

Professor Langley, of the Alleghany Observatory, having lately published in the *American Journal of Science*, and the *Memorie degli Spettroscopisti Italiani*, an article on the "Comparison of Theories of Solar Structure with Observation," in which certain supposed views of Father Secchi, of Rome, were referred to, the latter has replied at length in subsequent numbers of the Italian journal, commenting upon the researches of the American observer, and explaining his own views in such a way as to lead us to suspect a sudden conversion to views opposed to those he has advocated for so many years.

Father Secchi states his present view, which is, briefly, as follows, that a sun-spot is the product of an eruption on the sun, somewhat analogous to that of a terrestrial volcano.

The first stages of the eruption are, according to this statement of Father Secchi's latest opinion, occupied by the ejection of matter from the crater, which is what we call the *umbra* of the spot, and it is with these stages that the rose-colored flames or eruptions seen in the spectroscope are to be associated. This term "crater," however, is not to be understood as conveying the idea of a solid solar crust or shell, from which the jets escape into the chromosphere. On the contrary, he here entirely agrees with Professor Langley's view that the visible surface of the sun is essentially vaporous and cloudlike. This admitted, the analogy with the terrestrial volcano is elsewhere very close, for there is in both a second or intermediate stage during which the paroxysmal outbursts have ceased, though the ejected matters have not entirely stopped flowing from the crater; and a third stage, when, the eruption being fairly over, there is a gradual closing and extinction. Father Secchi claims that the observations of Professor Langley are quite consistent with this view, and adds that they are, in fact, very gratifying to him, as he is disposed to welcome them as bringing unexpected testimony to the truth of statements he made himself at one time, and which were then disputed. These American observations, then, may be called "beautiful," rather than fundamentally "new," in the opinion of Father Secchi, who believes himself to have more or less anticipated a large part of them; and, though agreeing that the resolution of the filamentary structure has been carried at Allegheny a step beyond that which he has reached at Rome, deems that this is accounted for by the fact that the American observer has the use of a larger telescope than the Roman observatory possesses.—*Mem. Soc. Spettrocopisti Italiani*, 1875, *January and February.*

ON AN ANCIENT ECLIPSE OF THE SUN.

Dr. E. Bretschneider, of Pekin, communicates to *Petermann's Mittheilungen* an account of the journeys performed by four Chinese scholars in the first half of the thirteenth century. Of these, the most interesting is that of Tschang-tschung, in 1221 and 1224. This distinguished monk of the Taoist order was at that time about seventy years old, and at the height of his renown. In the course of his journey he

experienced a total solar eclipse on the 23d of May, 1221, while traveling along the right bank of the Kerulun River. If the exact time and the place of the totality can be derived by Dr. Bretschneider from the Chinese record at his disposal, we shall have here one more contribution to our exact knowledge of the relative movements of the sun, earth, and moon. —17 *C*, XXI., 1875, 373.

TOTAL SOLAR ECLIPSE OF DECEMBER 11, 1871.

The government of India equipped an expedition, under the direction of Colonel Tennant, R. E., to observe this eclipse, and the results of the observations by Colonel Tennant, Captain Herschel, Mr. Hennessey, and others, are printed in the *Memoirs of the Royal Astronomical Society* (vol. lxii.), accompanied by four plates reproduced from photographs near totality. Spectroscopic as well as photographic records were made, and the polariscope was also employed. From these data Colonel Tennant's conclusions are derived, which he states as below:

"The following, then, seems to be the constitution of our sun. There is a nucleus which gives out continuous white light, like solid or liquid bodies, and even dense gases; surrounding this is a layer of heavy vapors, intensely heated, but far less so than the nucleus; in which, if a state of equilibrium could exist, the heavier vapors would be lowest. Above this is a layer of hydrogen of very slight density, accompanied by that gas which gives the line D_3. Still farther up these gases, in a cooler state, become mixed with what gives out the green line K 1474, and lastly that alone seems to remain. . . . We do not know any thing of the substance producing the chromospheric line D_3. Professor Respighi's observation at Podoocotta would go to show that it is inseparable from the hydrogen of the chromosphere. The substance, however, producing the green line K 1474 is one of the most interesting. We not only meet with evidence of its existence in the sun, but when the higher layers of our own atmosphere are reached we find at the great height at which auroras take place a substance which gives out a light apparently identical. Angström and Kirchoff have assigned the power of giving this line to the vapor of iron; but it seems nearly impossible that at the low temperature which we

know must exist in the upper strata of our atmosphere there can be iron vapor. Is it possible that iron possesses the property of occluding the gas whose distinctive line is K 1474? If it be so, this gas must be under ordinary circumstances of temperature and pressure almost immeasurably rare."

ON THE TEMPERATURE OF THE SOLAR SPOTS.

In presenting to the Paris Academy of Sciences the results of some of his observations upon the temperature of the sun, Mr. Langley, of Pittsburg, says that he has endeavored to repeat the observations made by Professor Joseph Henry in 1845, and Father Secchi in 1852. He has employed an ordinary achromatic refractor, after having first experimented with and laid aside a fixed horizontal telescope whose lenses were of rock-salt. The differences of temperature have been measured by an extremely delicate thermopile made of extremely small bars of bismuth and antimony, the exposed face of which has a diameter less than the sixth part of an inch, within which area are seen the ends of sixteen pairs of bars. This thermopile is connected with a Thomson's reflecting galvanometer. This combination possesses such an extreme sensibility that the galvanometer is, in spite of ordinary precautions, continually registering foreign radiations, such as would render indistinct the delicate phenomena that are the subject of the investigation. These disturbances are best removed by inclosing the pile within a blackened cylinder filled with water at a constant temperature. The image of the sun being about twenty-four inches in diameter, the thermopile can be placed at any part thereof with great accuracy. A second similar thermopile being placed in any other portion of the solar image, and connected with the same galvanometer, Mr. Langley was, by this differential arrangement, enabled to make the desired measurements. His observations confirm fully the original observations of Professor Henry, and have led him to further interesting results. From the known effect of the diminution of the light of the sun toward its borders, it seemed natural to conclude that a proportional diminution of the heat of the sun would be experienced. Mr. Langley, however, finds that the heat does not become insensible after we pass away from the visible border of the sun, but continues sensible at a distance of at

least thirty seconds of arc, which corresponds at the sun to fifteen thousand miles. He finds also that the whole amount of heat sent from the ring of photosphere around the sun is less than that received from the nucleus of a single solar spot.—6 *B*, LXXX., 748.

SOLAR SPOTS AND TERRESTRIAL PHENOMENA.

Fritz, so well known by his studies upon the aurora, and especially by his great chronological catalogue of auroræ, states that, after renewed investigation and comparison of thunder-storms in various portions of the earth, he is again forced to the conclusion that there is no perceptible definite connection between the frequency of thunder-storms and auroras, nor between these storms and the solar spots, so far as observations from over thirty places can afford any result. Some of the series employed by him reach back to 1755. He has also studied the series of observed heights of rivers, especially the Seine, at Paris, the Rhine, the Elbe, the Donau, and other German rivers. This comparison shows that between 1785 and 1844 there was a comparative coincidence in the periodical changes of depth of water and sun-spots, but that the law is reversed from 1844 to 1867, similarly to the reversal found by Professor Wolf, who compared the rainfall itself with the sun-spots.—*Klein's Wochenschrift*, 1875, 238.

ON THE RELATIVE TEMPERATURE OF VARIOUS PORTIONS OF THE SUN.

In a second communication to the French Academy of Sciences, Professor Langley, of Pittsburgh, has given the results of some measurements of the relative temperatures of the solar surface. This subject was first carefully investigated by Laplace, who showed that the solar atmosphere absorbed the light that emanates from its nucleus to such an extent that were its atmosphere removed we should receive twelve times more light than at present. The parallelism that exists between the phenomena of light and heat would lead us to expect a result somewhat of the same sort, in case we could measure the heat of the sun. Professor Langley has therefore compared the apparent temperature of every portion of the solar disk, as Bouguer did for the solar light

a hundred years ago. He finds the temperature to go on diminishing as we proceed from the centre to the limb of the sun; the heat is absorbed less than the light, and the principal absorption of the heat is confined to an extremely thin shell close to the photosphere. The heat that is received from the sun's edge is relatively much greater than the quantity of light. It would seem, therefore, that both at the solar limb and at the nucleus of the solar spots the light is cut off by the solar atmosphere in a much greater proportion than the heat. From the nucleus of a spot we receive fifty times more heat than light; and it becomes evident that the solar atmosphere exercises a selective absorption to a very marked degree. Father Secchi has stated that a decided difference in temperature is found if we compare the temperatures at the solar equator and the solar poles; but Mr. Langley finds, on the contrary, that the temperature is sensibly the same at all portions of the solar limb.—6 *B*, LXXX., 819.

ON OBSERVATIONS OF SHOOTING-STARS FROM BALLOONS.

In a balloon ascension made on the first of August, De Fonvielle states that seven passengers accompanied him, the ascent taking place at ten minutes of ten in the evening, and the descent at a quarter of four in the morning. The aeronauts had no lamps with them; but the starlight permitted them to recognize the route they followed. No instrumental observations could be made, but in lieu thereof the shooting-stars appear to have been carefully observed. Of these forty-two were counted in all parts of the heavens, some very brilliant. Eight or nine fell from the zenith in sensibly vertical paths. The evening twilight lasted until half-past ten; the morning twilight began at two o'clock.—6 *B*, LXXXI., 204, 205.

OBSERVATIONS OF THE SHOOTING-STARS OF THE 10TH OF AUGUST, 1875.

The shooting-stars that appear on the night of the 9th, 10th, and 11th of August are ordinarily known as the Perseides, inasmuch as their radiating point is in that constellation. They have been carefully observed in France during the past month; and from the observations made at Toulouse by his assistants, Tisserand concludes that besides

the principal radiant point in right ascension 47° and declination 56°, two other secondary radiant points existed, the positions of which were respectively right ascension 57°, declination 51°, and right ascension 64°, declination 63°. At least three fourths of the 1200 stars observed by them belonged to the first or principal radiant.—6 *B*, LXXXI., 317.

THE ABSORPTION OF THE SOLAR ATMOSPHERE.

Professor S. P. Langley, of the Allegheny Observatory, as a result of the photometric study of the solar surface, finds that the brightness of the umbra of the solar spots is considerably greater than that hitherto accepted. The blackest umbra being, according to him, from five to ten thousand times as bright as the full moon. The light of the sun is absorbed by the solar atmosphere in a greater proportion than is its heat. About one half of the radiant heat of the sun is absorbed, or suffers internal reflection by the atmosphere of the sun itself. This atmosphere is comparatively thin; new matter is constantly being added to it or taken away from it by the continual changes of the interior surface. The alteration in its absorptive power would materially affect the temperature of our globe, so that even the existence of life on our earth is evidently dependent upon the constancy of the absorption of this solar envelope. If there are, then, any cyclical changes in the depth of this solar atmosphere, they would be accompanied by corresponding cyclical alterations in the earth's temperature.—12 *A*, XII., 443.

VOGEL'S POSITIONS OF CLUSTERS AND NEBULÆ.

Dr. H. C. Vogel, already distinguished by his accurate observations of the positions of nebulæ and clusters at Leipzig in 1867, was engaged by Dr. Bruhns, the Director of the Leipzig Observatory, to co-operate in a work which that observatory had undertaken, namely, the re-observation of the stars down to the tenth magnitude, between the north declinations of 9° 50′ and 15° 10′. Dr. Bruhns so extended the plan proposed by the German Astronomical Society, which was concerned only with star-positions, as to include the determination of the position of all nebulæ and clusters within the zone, and this Dr. Vogel has executed. Dr. Bruhns's plan also includes re-observation of the double stars in his zone. Three

hundred and five nebulæ occur in this zone. Of these many have been previously well determined by D'Arrest and others, and Dr. Vogel accordingly devoted his labor to the nebulæ whose positions were uncertain, one hundred and forty in number. Each nebula was observed on two different nights at least, and Vogel finds the probable error of his final positions to be in R. A. $= \pm 0.09^s$, in $\delta = \pm 1.1''$. Between Vogel and Schönfeld the same personal difference remains which existed in 1867. Supposing both observers to have the same accuracy, the probable errors of a concluded position do not exceed 0.14^s in R. A., and $1.5''$ in declination. It will be noted here that these determinations are surprisingly accurate, and that the observations of D'Arrest, Laugier, Schultz, Schönfeld, and Vogel will serve to determine the proper motions of nebulæ if these are of important magnitude. Three star-clusters (G. C. 905, 1361, and 4440) have also been studied, and twelve nebulæ drawn. The nebula G. C. 2211 = h. 761 is probably variable in brightness.

SUPPOSED CHANGES IN THE OMEGA NEBULA.

Professor Holden has recently published the results of a careful study of all published drawings and observations of this nebula (R. A. $18^h\ 12^m$, N. P. D. 106.2°). The method adopted in the discussion of the drawings was peculiar, although perfectly simple and elementary. All the published drawings were photographed on the same scale, and in such a way that they represented the aspect of the nebula as seen in a *refractor*. They became thus strictly comparable, and any variation between the several drawings was at once evident. In all such delineations such differences exist, and the only difficulty in their discussion is to distinguish between real changes in the shape of the object itself, and apparent changes due to lack of fidelity in the drawing.

Professor Holden seeks to avoid this great difficulty by inquiring how the nebulosity in each drawing is situated with regard to lines joining certain pairs of stars, and terminated by these stars. It is probable that in a careful drawing no observer would lay down a certain star *outside* of a nebula when his telescope showed it *inside*. In this way the successive drawings of this nebula, from 1833 to 1875 (seven in all), have been studied, and the conclusion is arrived at that

"the western end of this nebula has moved relatively to its contained stars from 1833 to 1862, and again from 1862 to 1875, and always in the same direction."

The author also directs attention to the Trifid Nebula (G. C. 4355), which was suspected by Sir John Herschel to have a proper motion. Professor Holden confirms Herschel's suspicion. This is the first large proper motion detected in any nebula, and is of great interest in the theoretical questions relating to the distance and nature of these bodies. Both of these nebulæ will receive further attention.—4 *D, May*, 1876, 341.

COLORS OF DOUBLE STARS.

In the *Astronomical Register* for May, 1876, Mr. Sadler gives a list of sixty-three double stars, with the colors that he has noted for the components. His observations were made with a 6½-inch silvered-glass reflector (silvered-glass reflectors possess considerable advantages in such investigations, as the natural color of an object is less affected than when a refractor is used), and appear to have been made with great care. An interesting comparison with the work of former observers is given at the close of his paper. Smyth, Sestini, Herschel, South, Webb, Struve, and others are full of notes on this subject, which deserves attention, and is well suited to amateur observers.

THE RUGBY (TEMPLE OBSERVATORY) AND MR. GLEDHILL'S CATALOGUES OF DOUBLE STARS.

In the *Memoirs of the Royal Astronomical Society* (vol. xlii.) Messrs. Wilson and Seabroke, of Rugby School, have given to astronomers the results of their micrometric measures of double stars during the years 1871–74. The measures were made with the 8¼-inch equatorial by Alvan Clark which was formerly used by Dawes. Rugby has selected those even-numbered stars of Struve's Catalogue which are south of 50° of N. declination for subjects of observation, and records 1152 measures of these. The observations show great fidelity and skill on the part of the observers, and are a valuable contribution to this branch of astronomy.

Many interesting binaries were observed, some of considerable difficulty; and this catalogue will be an essential help

to investigators of orbits and to double-star observers. In the same volume Mr. Gledhill, of Mr. Edward Crossley's observatory at Halifax, gives the results of his measures of 484 doubles, which were made in concert with those of the Rugby Observatory, Mr. Gledhill observing those stars not taken by Rugby, in a list common to both observatories. Particular attention has been paid to the subject of binary stars, and it is announced that a work is in preparation on this topic.

Already the joint labor of these two observatories has decided the question of orbital motion in many cases.

ON THE ORBIT OF THE DOUBLE STAR Σ 634.

Otto Struve states that in preparing his micrometric measurements of double stars for publication, he came upon the star Σ 634, whose movements seemed to have especial interest. When the elder Struve compiled his well-known catalogue of new stars, the distance of the two from each other was nearly 37″. Their brightness was, on the average, as deduced from many estimations, respectively 4.5 and 7.9. To the great distance of these stars from each other is to be attributed the fact that they have been measured but seldom by good observers. At present the stars are about 20″ apart; their respective proper motions are nearly identical, but in direction are opposite to each other, and we are obliged to conclude that the two bodies may, in all probability, have some physical connection with each other, and are not merely optically double.—*Bulletin Acad. Imp. des Sciences, St. Petersburg*, V.

THE COMPANION OF SIRIUS.

It has been noted that the Washington observations of Clark's companion of *Sirius* do not agree with the computed positions from the theory of Auwers; the corrections to Auwers are—

1872.25	-5.6° in p	$+0.40''$ in s.
1874.18	-6.3° in p	$-0.46''$ in s.
1875.24	-7.2° in p	$-0.72''$ in s.

This is confirmed by the measures of Mr. W. Erck, of Ireland, who, under date of March 21, 1876, gives its position-angle as 55°. The Washington observations for 1876 give

the position-angle from measures taken from January 3 to April 8, as follows:

Hall (6 nights)	$p=55.22°$
Holden (6 nights)	$p=54.53°$
Mean	$54.88°$

The distance is still greater than 11″.

Lassell's new companion (more properly Marth's, as Lassell did not observe it; see *Mem. R. A. S.*, vol. xxxvi., p. 38) was seen by Mr. Erck $p=130°, s=75''\pm$. Marth's measure of 1865, Jan. 14, gave $p=127°, s=60''\pm$.—12 *A*, *March* 30, 1876.

THE VARIABLE STAR BETA PERSEI (ALGOL).

Dr. Julius Schmidt, Director of the Observatory of Athens, in continuance of his publication of the results of his long-continued observations of variable stars, has announced the definitive results of a thirty years' series (1845–1875) of observations on the variability of *Algol.* In the thirty years 285 minima have been observed, or an average of more than nine each year, and it is especially noteworthy that there is not a single year without at least three observations. These observations have been steadily pursued, whether at Bonn, Hamburg, Olmütz, in Greece, or at sea, with veritable assiduity. Argelander and Schönfeld have also carefully followed up this star, and Schmidt finds for the probable error of a single determination (of the time of minimum)—

Argelander	*p. e.*	$=\pm 6.04^m$	from	50	observations.
Schmidt	"	$=\pm 8.08^m$	"	183	"
Schönfeld	"	$=\pm 4.56^m$	"	55	"
Combination of all observers	"	$=\pm 7.01^m$	"	288	"

As an indication of the constant differences of these three observers, Schmidt deduces from simultaneous observations:

Schmidt—Argelander $=-3.89^m\pm 1.72^m$, from 21 observations (1846–58).
" —Schönfeld $=-0.79^m\pm 2.68^m$, " 17 " (1855–75).

The final result for the period of *Algol* is 2 days, 20 hours, 48 min., 53.60 sec.—38 *C*, No. 2077.

THE MOTION OF STARS TOWARD OR FROM THE EARTH.

It is known that the method of determining the motion of stars toward or from the earth by means of the displacement of a line in the spectrum of the star relatively to the position

of the same line in the spectrum of a Geissler tube held before the telescope has promised great results, and in the hands of Huggins and Vogel has yielded apparently reliable information. Secchi took up the problem in 1863, but without reaching satisfactory results, and attributed his negative conclusions at that time to the great difficulty and delicacy of the research. It is known, too, that the theory of Doppler (1842), upon which the principle of this method of research depends, has been seriously questioned by Van der Willigen. At Greenwich, during the past year, the question has been taken up on its observational side, and the results reached, which are often contradictory, have been published in the *Monthly Notices of the Royal Astron. Society*, vol. xxxvi., p. 30.

In view of these known difficulties, the recent researches of Secchi on this point are of great importance. He has prepared a table (a portion of which is reproduced below) in which the results of the various observers are exhibited. The sign + shows that the star was moving away from the earth, and — that it was approaching it.

STARS.	OBSERVERS.			
	Huggins.	Greenwich.	Secchi.	Vogel.
Sirius..........	+	—	—	...
α Lyræ..........	—	—	0	—
Procyon........	+	—	...	...
Castor.........	+	+	0	...
Regulus........	+	—	0	...
η Ursæ Majoris..	+	—	—	...

In his considerations upon the complete table, Secchi makes the following remarks:

1. That at Greenwich almost all the results are negative, a positive result being the exception; 2. The different days' results are quite discordant; 3. Huggins's results are nearly all +; 4. The results of Huggins as to the motion of Coggia's comet are not in accord with the known direction of this comet's motion; 5. The mean numerical results of the various observers are widely different. In view of these discordances, Secchi has made experiments upon *Sirius* with the object of determining whether there may be a *systematic source of error, either in the instrument or in the manner of observing, which may cause the displacement of the spectral ray.*

These experiments showed that a displacement could be produced on *either* side of the line of comparison by varying the method of observation, and Secchi comes to the conclusion that such systematic errors may appear without the observer having any sure means of detecting their existence. He points out that the agreement of a long series of such observations is no sure test of the star's motion, since the observer always places the instrument in the position where the vision is best. Further researches on this point are then most important.—6 *B*, *April* 3, 1876, 761.

DIMENSIONS OF THE SATELLITES OF JUPITER.

Taking a mean of the measures of the diameters of the satellites of *Jupiter*, by Struve at Dorpat and Engelmann at Leipzig, we have for the apparent diameters of the four satellites at the mean distance of the primary—

I. 1.048″; II. 0.911″; III. 1.518″; IV. 1.278″.

With a solar parallax of 8.875″, the true diameters in English miles will be—

I. 2435; II. 2115; III. 3514; IV. 2970.

The angular diameters at the centre of Jupiter are—

I. 31.4′; II. 17.1′; III. 17.8′; IV. 8.6′;

and the mean distance from *Jupiter's* centre—

I. 266,700 miles.	III. 676,800 miles.
II. 424,300 "	IV. 1,190,400 "

—12 *A*, *Feb.* 10, 1876, 288.

THE SATELLITES OF SATURN.

The 26-inch Clark equatorial of the Naval Observatory of Washington has been employed during the past opposition of *Saturn* in observations of his eight satellites. The results of five months' observations by Professor Hall are published in the *Astronomische Nachrichten*, No. 2076, and are very complete; especial attention has been paid to *Japetus* and *Titan*, with the object of determining the mass of *Saturn*. *Hyperion* (the faint satellite discovered by G. P. Bond) has been observed no less than forty times in this single opposition—an unprecedented feat, as even Lassell, in 1864, secured ten measures of position-angle alone.

Mimas was, however, only once observed. The accidental error of a difference of right ascension between *Japetus* and *Saturn* from a single wire is only $\pm 0.032^s$; and Professor Hall hopes that, by varying the method of observing during the next opposition, possible constant errors may be eliminated. The number of observations of each satellite is as follows: *Japetus*, 70; *Titan*, 43; *Hyperion*, 40; *Rhea*, 31; *Dione*, 31; *Tethys*, 29; *Enceladus*, 16; *Mimas*, 1.

PROPER MOTIONS OF SOUTHERN STARS.

Mr. E. G. Stone, Her Majesty's astronomer at the Cape of Good Hope, communicates to the Royal Astronomical Society a paper on the proper motions of 406 southern stars, which is printed in the *Memoirs*, vol. xlii., p. 129. After examination, Stone concludes that those of Lacaille's 9766 stars observed at the Cape of Good Hope in 1751–2 with the *altitude* instruments are available for this purpose, but the places given by the *rhomboidal micrometer* are not sufficiently accurate.

Of the first class there are 398, but 130 of these are identical with Bradley's stars, so that the material for accurate determinations of proper motions in the Southern hemisphere is less than might have been expected.

Stone bases his determinations on Brisbane (1825) [for N.P.D. only]; Fallows (1830); Johnson (1835); Henderson (1833); and a MS. reduction of Maclear (1840). The separate results from each catalogue are exhibited.

ORBIT OF THE BINARY STAR γ CORONÆ AUSTRALIS.

The orbit of this star, which is in R. A. 18h. 55m., and south declination 37° 18′, was investigated by Captain Jacob in 1855 (*Mon. Not. R. A. S.*, vol. xv., p. 208), his orbit being based on twenty-one years of observation. Schiaparelli has lately reinvestigated this orbit, and he finds that Jacob's orbit does not accurately represent the later observations. Accordingly he has deduced the elements which best satisfy the whole series (allowing, however, more weight to the observations since 1852), and finds the period of revolution to be 55.582 years, and the semi-major axis to be 2.400″. Schiaparelli's elements agree very closely with observation, and he adds an ephemeris extending to 1882.—38 *C*, No. 2073, 133.

ORBIT OF THE BINARY STAR 70 (*p*) OPHIUCHI.

Since the first measure of position of this star by Sir William Herschel in 1779, over two hundred separate observations have been made, which under ordinary circumstances would be sufficient to yield an accurate determination of the orbit. Sir John Herschel, Bessel, Mädler, and others have successively determined orbits for this binary, in no one of which has a satisfactory agreement of theory with observation been maintained over a considerable length of time. Tisserand, of Toulouse (aided by Perrotin of the same observatory), has given this orbit a thorough investigation, and he finds that the conditions of the problem are such that a partial indetermination exists in one of the elements. Therefore he has solved the equations of condition involving the elements, leaving one element undetermined; and he shows that, if the angles of position of this pair can be measured in 1885 so as to leave an error of not more than ±0.2°, the doubtful element can be determined with at least five times the exactness it now has. His complete work will be published in the *Memoirs of the Royal Academy of Toulouse* for 1876.—6 *B, January* 24, 1876.

THE DOUBLE STAR BETA LEPORIS.

This star is of the 3.5 magnitude, and was discovered to be attended by a small (eleventh magnitude) companion by Mr. S. W. Burnham, of Chicago, on December 14, 1874. On that date Mr. Burnham estimated the distance of the companion to be about 2 to 3 seconds of arc, the position-angle from two measures being 269.1°. Further measures have been made by Dembowski, of Milan, and Hall, of Washington, as below:

1874, December 14..	S=2″ to 3″;	*p*=269.1°—Burnham.	
1875.077...........	= .... ;	=268.4°—Dembowski.	
1875.112...........	= 2.89″ ;	=267.1°—	"
1876.068...........	= 2.71″ ;	=279.9°—	"
1876, January 31....	= 3.16″ ;	=280.4°—Hall.	
1876, February 17...	= .... ;	=283.6°—	"
1876, February 18...	= 3.08″ ;	=279.0°—	"

From these independent measures it appears that there has been a change of position-angle of no less than 10 degrees

in a little more than two years, which is a very rapid motion. This star may turn out to be an extremely interesting binary, and deserves the attention of all observers of double stars.

ON A CLASSIFICATION OF DOUBLE STARS.

Flammarion states that, in a general revision of double stars, he has divided them into classes, which have nothing in common with those of Herschel and Struve. These latter founded their distinctions upon apparent relative distances and magnitudes, whereas Flammarion has founded his classes upon the physical peculiarities of the different systems. He gives the name of *stellar systems* only to those of which 61 Cygni is the type, whose components, although physically associated and animated by a considerable common proper motion, do not revolve about each other, but move in straight lines. The name of *perspective groups* he gives to the double stars whose relative motions are in straight lines, but whose components are not physically associated, but are accidentally placed upon the same visual ray; one of which stars, therefore, is passing between us and the other by reason of a difference in their proper motions. Such double stars are far more numerous than the stellar systems, but less numerous than those whose components have remained relatively fixed since the time of their discovery. Of the stars belonging to the perspective group, an excellent example is found in Vega or Alpha Lyræ.—6 *B*, LXXX., 662.

ON THE DOUBLE STAR 61 CYGNI.

The observations made by Bessel in his work on the parallax of the star 61 Cygni led him to the conclusion that this double star was moving with great velocity, and that the two components were held together by the force of attraction, and were describing orbits about a common centre of gravity, the time of revolution being estimated at about 400 years, and the annual parallax at less than one half a second. The more recent observations of astronomers have, however, led Flammarion to conclude that no orbit as yet computed for this star will satisfy the observations, and that we are forced to conclude that the smaller of the two stars is moving with respect to the greater

one in a perfectly straight line. That they are intimately connected, however, there can be no doubt. The question is as to the nature of their orbits; and, with respect to this, Flammarion states emphatically that they do not revolve about each other. Is such a conclusion contrary to the law of universal gravity? At first sight it would seem to be so; and we may have therefore in these stars an exceptional case, instead of that powerful proof of universal gravity which was formerly supposed. But as, theoretically, it seems unwise to doubt the universality of this law, we are led to conclude that the two components of 61 Cygni form, in fact, possibly only a double companion to a more distant principal star, unless, indeed, one of them is at a great distance directly behind the other. The latter conclusion is favored by Flammarion, who cites several very similar cases of large proper motions in relative right lines.—6 *B*, LXXX., 171.

THEORY OF PLANETARY PERTURBATIONS.

In the *Analyst* for November, 1875, Mr. George W. Hill, of Nyack, New York, published an interesting and important mathematical paper on the development of the perturbative function in periodic series. He states that of the two methods ordinarily employed for developing this function, in one the numerical values of the elements involved are employed from the outset, and the results obtained belong only to the special case that is thus treated. In the other method all the elements are left indeterminate, and thus is obtained a literal development possessing as much generality as possible. It is with the latter method that his own investigations have to do, and his object has been to simplify as far as possible the formulæ that were published by Puiseux in Liouville's *Journal* for 1860, and those obtained by Bourget, as published by him in the same journal for 1873. He seeks to effect this object by the introduction of the Besselian functions. Mr. Hill's thorough acquaintance with the analytical treatment of the problem in hand gives to his little memoir of twenty pages a very high theoretical value, and renders it the most important mathematical paper that has appeared in the *Analyst* since the beginning of its publication; and the appearance of a few more memoirs of this stamp should, we think, render the

permanency of that journal a matter of certainty. It gives us, indeed, great pleasure to add that, according to a recent editorial announcement of Mr. Hendricks, definite arrangements have been made for its continuance for at least one, and possibly several years.—*Analyst*, II., No. 12.

ON THE SPECTRA OF THE NEBULÆ.

Dr. T. Bredichin, Director of the Observatory of Moscow, has lately investigated the spectra of various nebulæ, mostly planetary. The following (the numbers being taken from Herschel's General Catalogue in the *Philosophical Transactions* for 1864) have almost the same spectrum of three lines, viz., G. C. 4964, 4628, 4234, 4447 (annular nebula in *Lyra*), 4390, 4510. Regarding the three bright lines in these different nebulæ as identically the same, Bredichin deduces from his measures what he calls the *mean spectrum* of planetary nebulæ of this class, and he finds it to consist of three lines, A, B, C, of the following wave-lengths:

$$A=5003.9\pm1.2;\quad B=4957\pm1.4;\quad C=4859\pm3.1.$$

A and B, as Bredichin remarks, are nearly coincident with the strongest rays of *iron* (5005 and 4956.5) in the bluish-green portion of the spectrum.

The nebula 4244 gives a *stellar* spectrum; the spectra of G. C. 4532 (Dumb-bell), 4373, and 4572 are described. Bredichin speaks of a star in the centre of the disk of 4373, but it is worthy of note that neither Herschel nor Kaiser (who examined this nebula in 1839) describe this star. This deserves examination.—2 *G*, *Nov.*, 1875, 109.

ON PHYSICAL OBSERVATIONS OF THE PLANET JUPITER.

The physical changes that are seen to take place on the planet Jupiter have of late years attracted an increasing amount of attention by the possessors of large telescopes; and among these Bredichin, of Moscow, has published a series of eighteen photolithographs of the planet as observed by him in 1874. In making these he has employed a telescope of nearly ten inches' aperture, with a magnifying power of 250. He has distinguished six distinct regions, *a* and *f* being polar regions, *c* the equatorial, *b* and *d* the tropical, and *e* the region lying between the north tropical and north polar. The

zone *b* seems always to have had a color, which has been described as being somewhat green and somewhat blue. A very similar color may be remarked in a thick block of ice. The mean breadth of the equatorial band, *c*, was 9.7″, varying, however, from 7.7″ up to 13″. Luminous spots were frequently distinguished by him here and there, surpassing in brilliancy all other portions of the planetary disk. The variations of the bands *b* and *c* are especially noted by him. —*Bullet. Soc. Imp. Naturalistes Moscow*, 1874, 185.

THE ATMOSPHERE OF VENUS.

Prof. Watson, of Ann Arbor, in an address to the French Academy of Sciences, giving an account of his observations of the transit of Venus at Pekin, stated that at the height of about fifty-five miles, or one seventieth of the diameter of Venus, the atmosphere of that planet was liable to cause optical disturbance, such as would prevent the determination of the exact time of the real contact of its limbs with the sun's limbs, and therefore interfere with the determination of the solar parallax.—12 *A*, XII., 446.

ON THE BRIGHTNESS OF THE SATELLITES OF JUPITER.

Flammarion has made a series of observations of the brightness of the satellites of Jupiter in 1874 and 1875, in which he had in view the especial determination of the relative brightness of each of these, and the determination of their own reflecting powers, as well as the decision whether their brightness is variable, and in what proportions.

Among his observations he cites some showing that there is an atmosphere about each satellite, and, again, that the intrinsic reflecting powers of these four moons is not the same, but varies for each. Thus the fourth satellite is often dull and hazy, and although larger than the first and second, it is generally not so bright. Its surface is also not so white as that of the other satellites. We may then conclude with certainty that its substance, or at least its exterior surface, has less reflective power than that of the other satellites. Its brightness, moreover, varies considerably, and with no definite periodicity, and without any relation to the position of the satellite in its orbit: it is therefore not to any permanent spots on its surface that it owes its changes, but rather

to its own variable atmospheric phenomena. Its brightness varies between the sixth and tenth magnitudes. The dimensions of the four satellites (1, 2, 3, and 4) decrease in the order 3, 4, 1, and 2. The intrinsic brightness decreases in the order 1, 2, 3, and 4. The variability decreases in the order 4, 1, 2, and 3.—6 *B*, LXXXI., 145, 233.

METEORS OF AUGUST 10TH–11TH, 1875.

The August meteors were observed at Lisbon, in 1875, with the following results:

10^h–11^h, 43 meteors; 11^h–12^h, 96; 12^h–13^h, 241; 13^h–14^h, 331; 14^h–15^h, 385; 15^h–16^h, 131. Total, 1227 meteors in six hours, or an average of 205 meteors per hour.—22 *B*, 1875, No. 266.

SPECTRA OF THE GASES CONTAINED IN METEORITES.

Professor A. W. Wright, of Yale College, in 1875 examined spectroscopically the gases derived from the meteorite which fell in Iowa County, Iowa, February 12, 1875. This was of the ordinary stony kind, containing, according to an analysis by Professor J. L. Smith, 12.54 per cent. of nickeliferous iron, and it was investigated in order to determine whether the spectrum of the gases evolved from it by heat would afford any information respecting the recent theories connecting such meteorites with comets.

The spectrum obtained was chiefly that of the carbon compounds, and showed a very close resemblance to the spectra of several of the comets. It was stated at that time that the nature of their gaseous contents establishes a marked distinction between the stony meteorites and the iron meteorites. Professor Wright has lately taken up this investigation, with the view of making a more extended comparison of the gases from the two classes, and the results of his examination of several specimens of both classes justifies his former conclusions. All suitable precautions were taken in obtaining and preserving the gases, and portions of the Iowa meteorite were re-examined with the result of confirming previous conclusions.

Professor Wright is still engaged on this research, but he considers the evolution of such large volumes of carbon dioxide as characteristic of the stony meteorites, and the re-

lation of these meteorites and their contained gases to the modern theory of comets is certainly of great interest.—4 *D, April*, 1876, 262, *and July*, 1875.

THE ATMOSPHERE OF VENUS.

Mr. H. C. Russell, government astronomer to New South Wales, in giving an account of the observations made by the various parties stationed there on the transit of Venus, goes into some detail on the subject of the observed halo about the planet Venus, and its possible explanation. Most of the observers state that for some minutes before the first internal contact the whole of the planet's outline could be seen, and three distinct phenomena appeared to be distinguishable: First, a broad ring of light, outside of the planet; second, a bright ring of light around that part of the planet projected on the sky; third, a band of light around the inner edge of the planet, or over its surface. No spots were seen on the planet. The first, or halo, seems to Mr. Russell not likely to be due to any atmosphere. It is a phenomenon, in fact, seen only by some observers and under special conditions. The second, or bright ring, is the most interesting physical feature observed; although at first it would seem to be due to an atmosphere somewhat similar to that of the earth, yet Mr. Russell thinks that a little consideration will show that it can not have such an origin. It is spoken of by all observers as very brilliant, and its actinic power was so great that, although it could appear only as a fine line in the photo-heliograph less than 0.002 of an inch in diameter, it yet had power to affect the chemicals in something less than the 0.004 part of a second. In other words, it was quite as powerful, even more so, than direct sunlight. Mr. Russell thinks that an envelope of some perfectly translucent substance, such as water, would alone suffice to account for all the observed facts.—*Trans. Roy. Soc. of New South Wales*, 1874, 111.

DIAMETERS OF THE INFERIOR PLANETS AS AFFECTED BY DIFFRACTION.

André, of the Observatory of Paris, has undertaken a research on the diameters of Venus and Mercury as affected by the phenomenon of instrumental diffraction, in connection with the observations of the transit of Venus in 1874, which

is of great interest, as this phenomenon is manifest not only in such observations, but in all cases where a telescope is employed for determining the place of the centre of a body by means of observations on its border or limb. The values of the diameters of Venus and Mercury obtained micrometrically, under ordinary conditions, are always greater than those obtained during a transit, and differ the more according as the aperture of the telescope employed is greater or less. Thus, during the transit of 1874, Mouchez obtained, with an equatorial of eight inches' aperture, the diameter of Venus as 64.38″; the observations of Main, at Greenwich, using a telescope of six and a half inches, and Plummer, of Durham, with about six inches' aperture, gave a diameter of 64.73″. This result comes from the fact that the image of a luminous point given by a telescope is not a point, but a disk surrounded by rings alternately dark and bright, whose diameter diminishes with an increase of aperture. The *difference* of the diameters of Venus or Mercury, obtained by the same instrument during a transit, and under ordinary conditions, should be double, or nearly double, the diameter of the disk of a star (a point) given by that instrument, or at least a quantity of the same order. The observations of Tennant and Main on Venus, and Plummer and Main on Mercury, give 0.724″ and 0.602″ for this quantity, and theory based on measures of Dawes and Foucault gives for the same quantity 0.854″. The practical effect of this is that the observations of the transit of Venus should be reduced to what they would have been provided all the telescopes had the same aperture (in the equipment of the American parties this was provided for by making all the equatorials of the same aperture, viz., five inches), and for this purpose André seeks to determine what he calls *the equation of instrumental diffraction.* To show the effect of this, he gives the following observations of the first internal contact at St. Paul's Island during the transit of Venus in 1874:

Observer.	Aperture.	Uncorrected Time.	Time reduced (Aperture 4 inches).
Mouchez..........	8 inches.	19*h.* 39*m.* 2.5*s.*	19*h.* 38*m.* 48.3*s.*
Turquet...........	6 "	38 56.1	38 46.5
Velain............	2.5 "	38 31.0	38 48.0

—6 *B, January* 17, 1876, 205.

In a second memoir on the same subject, André describes experiments made in a dark room with a telescope of 0.10^{m} aperture (1.24^{m} focal length), which was diaphragmed down to 0.017^{m}. His observations were made on an illuminated slit in a plate of copper, which could be made to appear bright on a dark ground or dark on a bright ground. He also measured the distance between the borders of two such slits lighted from behind, and separated by about the width of each of them. In the first case the difference of the diameters *observed* was 15.82″ for an aperture of 0.017^{m}, and 6.16″ for one of 0.049^{m}, and this difference *calculated* was 15.68″ and 5.33″. [O – C = + 0.14″, and + 0.83″.] In the second case the differences between observation and calculation were O – C – 0.78″, + 0.39″.

André mentions among the consequences of this law two of immediate importance in the reduction of the French observations: First, the differences of longitude determined by the transits of the moon's limbs (first and second) *may* vary by so much as 3.5^{s} of time, when the longitudes are determined by transit instruments of the size furnished to the French parties. Second, in the occultations observed at Greenwich, discussed by Breen, and used by Newcomb to determine the coefficient of parallactic inequality, a correction of + 1.1″ is applied to the lunar diameter, in order to take account of the increase of the moon's diameter by irradiation.

André is of opinion that this correction should not be applied, and that consequently Newcomb's value of the solar parallax from this datum (8.444″) should be diminished by 0.07″; and he expresses his belief that the results of the late transit of Venus will give a value of the solar parallax at least as trustworthy as those derived by other methods, provided a suitable selection of the best observations is made, that selection to be based on proper physical discussions.—6 *B*, 1876, *March* 13, 607.

AN ANCIENT DISCOVERY OF A VARIABLE STAR.

Beaudet calls the attention of the Academy of Sciences of Paris to the fact that among the rare pieces of apparatus in the collection of the Bureau of Arts and Machinery, there is a celestial globe dated 1622, constructed by W. J. Blaen, of Amsterdam. This geographer was originally a student of

Tycho Brahe, and subsequently devoted himself to the construction of globes, which he made in great perfection, of three different dimensions. His larger celestial globes, in a space near the constellation Cygnus, mention the discovery, in 1600, of a new star in the breast of the Swan. Kepler stated, in 1606, that this star had been discovered by Blaen himself; the date of the discovery was the 18th of August, 1600. At that time it was of the third magnitude. It soon after diminished until it became invisible to the naked eye, and only became visible again in 1670, when it again attained a third magnitude, lasting two years; but faded away, and has not since been observed. Possibly it will appear again about 1880.—6 *B*, LXXXI., 335.

THEORY OF THE SATELLITES OF JUPITER.

The present predictions in the Astronomical Ephemerides of the phenomena of Jupiter's satellites are based on the tables of Damoiseau, which extend only to 1880. The predictions of *eclipses* are in error, by the observations of Mr. D. P. Todd, at Amherst College, in 1875 (with a four-inch aperture), by the following amounts:

I. Satellite;	Correction	to	Tables	+ 53.0^s	for a	Disappearance;	16	obs.
II. " ;	"	"	"	+ 11.8^s	"	" ;	8	"
III. " ;	"	"	"	+ 24.1^s	"	" ;	4	"

M. Souillart has re-examined, in several memoirs published in *Annales Scientifiques de l'Ecole Normale Supérieire* (t. ii., 1. série), the theory of these satellites as delivered in the *Mécanique Céleste*, making use, however, of a different process from the one followed by Laplace. His results have in general confirmed the previous theory. New researches by M. Souillart lead to some important modifications in the values of Laplace's coefficients. These latest researches will soon be published with others, so as to furnish a complete theory of the motions of Jupiter's satellites, together with tables, now so much needed.—6 *B*, *March* 27, 1876, 728.

ON THE PARALLAX OF 1830 GROOMBRIDGE.

The star 1830 Groombridge, which is so famous on account of its extremely large proper motion, has for forty years been a favorite subject of measurement for the determination of its parallax. The most recent observations of this charac-

ter are those by Professor Brunow, of Dublin, whose result, 0.097″, is of the highest apparent value. Previous to him, the other determinations that had been made were as follows: Otto Struve, 0.034; Wichmann, 0.114; Schluter, 0.166—or on the average, 0.118; which latter value, as given by Auwers, can not be suspected of a probable error greater than 0.02. These four values of the parallax are, strictly speaking, only relative parallaxes of the star in question, as compared with four smaller neighboring stars. In a highly instructive memoir by Auwers on the parallax of this star, he shows that, although the heliometer used by Johnson at Oxford in 1852 and 1853 was one of the finest in existence, and ought therefore to have yielded a result of great value, yet the results attained by him can not be considered worthy of comparison with those made by the four observers before mentioned, on account of defects in his method of observation. Johnson's observations are subjected by Auwers to analysis in the usual thorough manner of that able computer, an analysis facilitated by the fact that he has himself made a series of similar measurements with Bessel's heliometer at Königsberg. The best result that Auwers is able to deduce from Johnson's observations attributes to the star a parallax whose probable error is larger than the parallax itself, and that, too, without representing the original observations any better than the simple assumption of no parallax at all.—*Monatsbericht Acad. der Wissenschaften, Berlin*, 1874, 569.

MOVEMENT OF A PLANET IN A RESISTING MEDIUM.

Among the many problems relating to the planetary motions, that of the movements of a point under the influence of the force of gravitation and of a resisting medium offers always a high interest. This has been made the subject of the inaugural dissertation of Dr. Hermann Hohnhorst, who has considered the resistance of the medium to be proportional to its density, and to the square of the velocity of the moving body. The integration of the elementary differential equations is sought to be accomplished by him by the application of the theory of the variation of the arbitrary constants. By this means he is led to four equations, giving respectively the variations of the major axis, the eccentricity, the inclination, and the longitude at the initial time. The

complete integration of these four equations is effected by him by the use of elliptic integrals and the so-called *theta* function.

THE URANIAN AND NEPTUNIAN SYSTEMS.

No sooner was the 26-inch refractor at Washington in working order than its powers were tested by an examination of the planets Uranus and Neptune, in order to ascertain how well the satellites of those planets were visible by its means. The two nearest satellites of Uranus had never been recognized as such by any astronomer until Lassell's telescope was mounted at Malta, nor again after that until they were observed at Washington. The results of the first year's observations of these satellites are now published in a memoir by Professor Simon Newcomb on the Uranian and Neptunian systems, accompanied by tables whereby the apparent positions of the satellites may in a few minutes be predicted with sufficient accuracy. Apart from the determination of the exact positions and movements of the satellites themselves, Professor Newcomb's memoir finds its highest interest in the fact that he deduces from these observations new determinations of the masses of the two principal planets. His results have an intrinsic accuracy far surpassing that of the very discordant results given by previous observers, and his long series of unprecedentedly exact observations (although the objects observed by him are justly considered the most difficult that offer themselves to the astronomer) is a fine testimony to the correctness of the principle adopted by him that, "in the present state of astronomy, it is better to do one thing well than many things indifferently."

Among the more important results, Professor Newcomb states that we are led to the remarkable conclusion that the eccentricities of the satellites of the two outer planets are insensible so far as they can be determined from all the observations hitherto made on them, and that in the case of Oberon and Titania the orbits are more nearly circular than in the case of any of the large planets of our system. The most probable value of the mass of Uranus is, he concludes, $\frac{1}{22800}$, with a probable error of 100 in the denominator. For Neptune, Professor Newcomb finds that the mass is $\frac{1}{19380}$, with a probable error of 70 in the denominator. He adds

that he can say with considerable certainty that there is no satellite within two minutes of the planet Uranus, outside of Oberon.—*Appendix I. to the Washington Observations for* 1873.

OBSERVATIONS ON THE ZODIACAL LIGHT.

In the volume of observations on the zodiacal light, published by Heis, he gives a slight historical sketch of the observations of that phenomenon, from which it appears that his own observations were begun by him at Aix-la-Chapelle in 1847, and continued by him there until 1852, since which time they have been pursued at his residence at Münster. In 1864 Weber, at Peckeloh, began to assist him. In 1843 to 1845 Schmidt, of Athens, and in 1853 to 1856 Rev. George Jones, of the United States, observed the zodiacal light. A large number of other observers are mentioned by him, from whose observations he has drawn liberally in compiling such notes as he has thought appropriate. The total number of zodiacal-light observations given by him is thirty-four, most of them observed very fully by at least one person, and oftentimes by two. Some of the records are much fuller than others, but in all sufficient is given to find the exact place of the light, its limits, its apex, and axis.—*Zodiacal Light Observations by Edward Heis, Münster*, 1875.

THE COMET III., 1862.

This comet threw out in the neighborhood of the sun a second and supplementary tail, which was carefully observed by Schiaparelli at Milan (*Pub. dei R. Oss.*, etc., ii., p. 21). Bredichin, of Moscow, has discussed these observations on the supposition that this tail was in the plane of the orbit, and he computes for each observation the angle of the tail and the radius vector, the length of the tail, etc. The values of these quantities show that the tail preceded the radius vector in its motion through space, and that the force which was necessary to the formation of the tail was in terms of the force of gravitation (=1) 1.013. Supposing this force to be 1.000, Bredichin computes the velocity of the luminous jets for this comet, and finds it to be equal to 0.02; for Halley's comet Bessel found this velocity 0.04; for the comet of 1858 this was 0.14; for the comet of 1811 it was 0.17.

Dr. Bredichin will shortly publish a complete discussion of this interesting subject.—38 *G*, LXXXVII., 239.

ORBIT OF COMET II., 1840.

This comet was discovered by Galle, of Berlin, January 25, 1840, and was observed until the end of March. Dr. Kowalczyk, of Warsaw, has recently reinvestigated its orbit from a good number of observations, and finds it to be an ellipse, the periodic time being 3789 years. The agreement of observation with his theory is very close. Plantamour and Loomis had previously investigated this orbit, and their results may be found in *Astronomische Nachrichten*, No. 476, and *Transactions of the American Academy of Arts and Sciences*, vol. viii. Plantamour's orbit was parabolic, and represented the Geneva observations well; Loomis's was an ellipse, which corresponded to a periodic time of 2420 years; Kowalczyk's, however, agrees so well with all the observations that this orbit may be considered as settled. —38 *C*, LXXXVII., 225; 12 *A*, *March* 16, 1876, 386.

ON THE CALCULATION OF THE ABSOLUTE PERTURBATIONS OF COMETS.

Professor H. Gyldèn, Director of the Astronomical Observatory at Stockholm, communicates to the Paris Academy of Sciences a method of calculating the absolute perturbations of comets. He states that in all cases where the solution of the problem of these bodies can possibly be effected by developing the expression for the perturbing forces into a series depending upon their powers and products, the principal difficulty is experienced in the evaluation of two consecutive quadratures, the first of which is ordinarily performed by means of a series depending upon the sines and cosines of the eccentric anomaly. This method, however, becomes inapplicable in the case of comets whose orbits are ordinarily very eccentric. In order to meet this case, Hansen has invented the method of partitions, in which he divides the comet's orbit into successive portions, and introduces into them new variables called partial anomalies; the variables for one partition being connected with those of the next by a discontinuous function. Professor Gyldèn's method consists in modifying that of Hansen, by introducing an elliptic

integral in place of the discontinuous variable, by means of which, it is said, he is able to compute the perturbations with ease, even in the most difficult cases.—6 *B*, LXXX., 808, 907, 1070.

SPECTRUM OF COGGIA'S COMET.

Some accurate observations of the spectrum of Coggia's comet of 1874 were made by Bredichin, of Moscow. The greater part of his work was done by means of a spectroscope by Merz. The values of the scales used by him were determined each night by comparison with a Geissler's tube. The channels observed in the cometary spectrum coincide with those of the bands in the spectrum of the hydrocarbons, whose wave lengths are respectively 563.3, 516.4, and 474.2. —*Bullet. de la Soc. Imp. des Naturalistes de Moscou*, 1874, 146.

THE PERIODIC COMET OF D'ARREST.

The periodic comet of D'Arrest was discovered in 1851 by that astronomer. Its orbit about the sun was computed with considerable precision by Villarceau, who allowed for some of the perturbations to which it was subjected by the attractions of the planets. His work has been recently taken up by Le Veau, and carried to a considerable degree of refinement; the inclination of the plane of the comet's orbit to the plane of the ecliptic is only fourteen degrees. A special difficulty, however, arose from the fact that in 1861 the comet approached very near to the planet Jupiter, and the influence of this great body was so considerable that the variations in the perturbations were sensibly of the same order as the changes in the elements of the comet's orbit, so that, in order to obtain the corrections to the latter, the ordinary equations of condition would not suffice. This difficulty was overcome by employing the method of false position. The twenty-two resulting equations were resolved by the method of Cauchy. The mass of Jupiter employed in these computations is that deduced by Bessel from observations of the satellites of that planet; and the results of Le Veau's observations show that no material change in the mass of Jupiter is needed, although the new observations of this comet at its successive apparitions will probably enable the astronomer

to determine the mass of that planet with very great exactness.—6 *B*, LXXXI., 141.

THE LUNAR THEORY.

The theory of the movements of the moon, which has occupied so many astronomers since the days of Laplace, or, more correctly speaking, since the days of the earliest Chaldean observers, has most recently received some additions by the labors of Schjellerup, who has paid especial attention to the acceleration of the moon's mean motion, and the identification of the eclipses that are recorded by the ancient astronomers. Schjellerup has especially sought for confirmation of his investigations by computing the eclipses recorded in the Chinese classics, as published by Dr. Leggie. Among the eclipses subjected by him to computation are those which occurred 708 years B.C., 600 years B.C., and 548 years B.C. —*Oversigt Kongelige Danske vid. Selsk.*, 1874, 61.

ASTRONOMICAL OBSERVATIONS AT MANNHEIM.

In the volume of astronomical observations at Mannheim, recently published by Schönfeld, he gives the observations of nebulæ and stellar clusters that have been made by him since 1862, amounting in all to eight hundred and twenty complete measurements of the distances between nebulæ and neighboring stars. His object has been to determine the positions of as many nebulæ as possible, as accurately as he could by measuring micrometrically their distances from neighboring stars. In this work, in which he was almost the only observer twenty years ago, others have also become active since then, and have even surpassed him in the quantity of work done, though not in quality.

The condition of the atmosphere has been carefully noted by him at each observation. The constant differences between his own positions and those of other observers, such as Schultz, are very small.—*Astron. Beob. auf der Grossen Sternwarte zu Mannheim, Dr. E. Schönfeld*, 2. Abth., 1875.

ASTRONOMICAL OBSERVATIONS AT MILAN.

The recent publication No. 5, from the Royal Observatory at Milan, contains various astronomical observations, among which are especially prominent the photographic plates rep-

resenting Coggia's comet of 1874, a chart of the Pleiades, and a lithographic plate representing the phenomena of the lunar eclipse of the 1st of July, 1863. In the latter the varied colorings of the portions of the disk of the moon are very striking. In the chart of the Pleiades, the nebula around Merope is represented as very distinct. There seems to be good reason to doubt the variability of this object. The series of drawings of the comet of 1874 appears to be remarkably complete, and is very skillfully executed.

THE GREAT PARIS TELESCOPE.

The great telescope at Paris is now quite complete, except in a few minor matters. It was officially exhibited on the 7th and 9th of October. The mirror is 47 inches in diameter, with a focal distance of 23 feet. The weight of the mirror is half a ton; it is constructed of glass, and is silvered by the Foucault process. A metallic mirror of the same size would probably weigh four tons. The cost of the mirror was £2000. The telescope is mounted like an ordinary equatorial refractor. A magnifying power of 500 has been found to answer excellently for observing minute stars. The finder, together with the ocular and the small plane mirror, are all placed at the front of the tube, and can be rotated around its axis, thus facilitating the use of the large iron winding staircase from which observations may be made. The height of this staircase is about 40 feet, and its weight six tons. It rests on two circular iron rollers, and is always placed on the same side of the tube as the counterpoise. It is moved by special machinery. The observations are made in the open air, but the instrument is protected at other times by means of an iron house, which building weighs twelve tons, and is movable on rollers by means of special machinery, so that it can be rolled to one side, and in less than a quarter of an hour the huge telescope can be uncovered and pointed upon any object, however minute. The entire cost of the telescope and appurtenances has been £8000, and it has occupied six years in building, the work having been interrupted several times by the events of the civil war and other matters; its final accomplishment is due to Le Verrier's perseverance. This distinguished astronomer now contemplates undertaking a large refractor,

having a focal length of about 55 feet. Its construction will probably occupy three years. The appropriation initiating this new work has already been made.—12 *A*, XII., 538.

LARGE TELESCOPES.

It is announced that the principal refractor of the new observatory at Vienna is to be manufactured by Grubb, of Dublin, the order for its execution having already been given. The object-glass will have an aperture of about 27 inches, according as the disks of glass turn out, these latter being manufactured in Paris. The axes will all have their friction relieved by anti-friction apparatus. The tube will be entirely of steel; and all the various motions of the instrument, as well as the readings of the different circles, will be available to the observer from the eye end. The telescope will be mounted completely at Mr. Grubb's new workshops, and covered by a corrugated iron roof fifty feet high. The latter is but a temporary structure; outside of it will be erected a splendid steel dome originally designed by Mr. Grubb, which, after being tested at Dublin, is to become in Vienna the permanent shelter of the mounted refractor.—12 *A*, XII., 517.

THE SPECTROSCOPIC OBSERVATORY AT CALCUTTA.

Rev. E. Lafont, Rector of St. Xavier's College at Calcutta, has addressed the President of the Asiatic Society of Bengal a letter in which he says he proposes to erect a spectroscopic observatory at the college, where daily observations and maps of the solar protuberances will be made. As this undertaking is entirely for the benefit of science, he ventures to request such assistance and subscriptions as may be necessary. The total sum required is about ten thousand reals, toward which the council of the society has contributed five hundred. He states that the pressing invitation of his friend, Professor Tacchini, first induced him to attempt the establishment of a spectroscopic observatory.—*Proceedings of the Asiatic Society of Bengal, February*, 1875.

THE SOLAR ATMOSPHERE AND RADIATED HEAT.

Mr. John Ericsson has published a portion of his solar investigations in a special memoir (privately printed in New

York), in which he gives the results of his investigations into the difference of intensity of heat transmitted from different parts of the sun's surface. His instrument has a focal length of fifty-eight feet, being a telescopic tube of that length, within which diaphragms may be placed so as to expose to view only definite small portions of the solar disk. By means of three actinometers which record simultaneously the rays of heat received—first, from the entire area of the solar disk, second from a central region, third from a zone at the border—he is able to arrive at the desired comparison. In order to insure greater exactness, he surrounds his three actinometers with wooden jackets through which a steady stream of water is circulated, thereby keeping the chambers at a uniform temperature. He concludes that the radiation at the edge of the solar disk is but two thirds of that at the centre, while the total absorption of the solar atmosphere is about one seventh of the radiation emanating from the photosphere.—*Ericsson's Solar Investigations, New York*, 1876.

DISTRIBUTION OF STANDARD TIME IN SWITZERLAND.

The report of Professor Hirsch, Director of the Observatory of the canton of Neuchatel, in Switzerland, gives an account of the methods adopted at Neuchatel for distributing accurate time throughout the neighboring country. He says the importance of telegraphic transmission of astronomical time for the development of accurate horology is fully appreciated both in Neuchatel and the neighboring cantons. Gradually the system of transmission of time has been extended so as to embrace even the canton of Vaud; and, among other cities, those of Neuchatel, Geneva, St. Croix, Locle, and numerous other stations. In accordance with a formal agreement between the canton of Vaud and the canton of Neuchatel, the government of the former pays an annual sum toward the support of the Neuchatel Observatory; the organization of the whole service being left with the observatory, but the local expenses of receiving time signals are charged to the government of the canton of Vaud. It would seem, however, that the organization of the astronomical and telegraphic work has not yet reached the perfection which it has attained in England, since it is reported since last year that the signal at one station has ceased altogether, while at another it was

received only 74 times. At Locle the signal was missed 128 times, and at Chaux-de-fonds it was missed 92 times in the course of the year. These imperfections are attributed directly to the want of proper telegraphic facilities; and the experience of fifteen years has shown the force of the recommendation of the director of the observatory, who urges that he should have under his control a special telegraphic wire for the use of the observatory, at least during certain hours of the day. The testing of chronometers is undertaken by the observatory at Neuchatel on a very large scale for the benefit of the chronometer-makers of Switzerland. The total number tested being 239 during the year. The mean average daily variation of the marine chronometers has been 0.02 of a second of time. First-class pocket chronometers, 0.44 of a second; second-class pocket chronometers 0.55 of a second; and, in general, only five per cent. of the chronometers show a mean variation exceeding half a second. It is reported that the anchor escapement steadily acquires favor both among manufacturers and the public. The chronometers having a Breguet flat spiral hair-spring show a superiority over all the others, except those having Phillips's flat spiral, or double curvature. Although the number of marine chronometers is very small, yet they have shown a remarkable excellence, especially the one presented for testing by Henry Grandjean, of Locle, which stands at the head of the list for the perfection of its temperature compensation.—*Bulletin Soc. des Sciences Naturelles, Neuchatel*, 1875, X.

EGYPTIAN CHRONOLOGY.

South communicates to the Academy of Sciences at Munich an exhaustive memoir on the Sothis or Sirius period of the old Egyptians. He intends his memoir on Egyptian chronology as complementary to that on Egyptian history which he published some five years ago. From his complete review of the subject we note that he concludes that the fifty-second year of Sesostris coincides with the Phœnix epoch, or 1525 years B.C.; and the eighth year of Rameses III. coincides with the Sothis epoch, or 1325 B.C. And he therefore finds no reason for changing materially the traditional exodus of the Hebrews, usually put at 1490 B.C., in which he differs somewhat from Lepsius, who places the exodus under

the reign of Menoptah, about 1314 B.C.—*Sitzb. Acad. der Wissenschaften, Munich*, 1874, 84.

LIST OF LOGARITHMIC TABLES.

In the last volume of the memoirs of the Royal Academy of Sciences of Amsterdam, Biereus de Haan gives a list of published tables of logarithms, in continuation of a similar list published by him in 1862. The latter contained 267 titles; the present list, however, contains 553. Of these, 57 were published in the Netherlands, 144 in England, 178 in Germany, 91 in France, 23 in Italy, 22 in Denmark, Sweden, and Norway; 9 in Spain and Portugal, 9 in North America, and others elsewhere: 47 of these were published between 1614 and 1649, inclusive; 51 from 1650 to 1699; 48 from 1700 to 1749; 73 from 1750 to 1799; 199 between 1800 and 1849. While most of the tables give the logarithms to 4, 5, 6, or 7 places, 13 give them to 10 places. One table gives 50 places; four give 60 or 70 places, and one gives 102 places. This latter was published in 1871 at New York as a duodecimo, under the title of "Astronomical Tables," by H. M. Parkhurst.—*Verhand. Kön. Akad. Wetenschappen, Amsterdam*, 1875, XV.

CALCULATING MACHINES.

Mr. George B. Grant, while a student of the Lawrence Scientific School, invented a new and simple form of calculating machine, which is now on exhibition in Machinery Hall, Philadelphia. Two styles are now made, the first being for special use, while the second is intended for use in counting-houses, insurance offices, etc.

THE DIFFERENCE ENGINE.—This is a large machine built for the University of Pennsylvania, and designed for the construction of large mathematical tables, such as tables of logarithms, sines, tangents, reciprocals, square and cube roots, etc. It computes the terms of any such table, and prepares a mould of them stamped in wax, from which an electrotyped plate is made, ready for the press. It stands five feet in height by eight in length, weighs 2000 lbs., contains, when in full working order, some 15,000 pieces, and is worth about $10,000.

THE CALCULATING MACHINE is a smaller instrument for

common operations in multiplication, division, etc. It is a foot in length by half as much in height and width, weighs twenty pounds, and contains less than 400 pieces, less than 75 of which are working parts. It takes numbers up to nine decimal places. Its mechanism is simple, strong, and durable; its manipulation is easy.

SPECIAL TREATISE ON DOUBLE STARS.

A work is now preparing in England which will be of importance to all observers of double stars, and to those interested in the calculation of the orbits of binary stars. Its joint authors are Mr. Gledhill, Mr. Crossley, and Mr. Wilson of England, all expert double-star observers, and Dr. Doberck, of Markree, Ireland, to whom we owe the investigation of many orbits of binary stars.

Mr. Gledhill is to write on the observations of double stars, binary star-orbits, and the history of the subject; Mr. Crossley describes the various micrometers and their use, etc.; Mr. Wilson gives an account of the various graphical methods of calculating orbits of binaries; and Dr. Doberck treats of the analytical investigation of such orbits, with examples chosen from his researches on *Sigma* and *Gamma Coronæ*.

THE CORONAL-LINE 1474 K.

The line 1474 of Kirchoff's scale, which is reversed in the spectrum of the solar corona, is known to nearly coincide with one of the short lines in the iron spectrum when the Leyden-jar spark is used (not with the electric arc between carbon points). Even with powerful spectroscopes it appears in the solar spectrum as a fine, hard, black line. Professor Young, of Dartmouth College (the discoverer of the line in the solar corona), has examined and mapped the neighborhood of this line in the diffraction spectrum produced by reflection from gratings ruled by Mr. L. M. Rutherfurd; and he finds this line to be unmistakably double. The two components are separated by a distance of about $\frac{1}{4}$ of a division of Angström's scale, i. e. about $\frac{1}{24}$ of the distance of the D lines. The more refrangible component (which Young considers to be the coronal-line) is heavier and more hazy than the other, which is well defined. Three gratings (6480, 8640, and 17,280 to the inch respectively) have been used,

and the observations have been most easily made in the 8th order spectrum in the second of these, or in the 5th order with the third.

The spectra are viewed by reflection from the surface of the grating, and to separate the spectra of the higher orders a 45° prism is placed between the grating and the observing telescope. By this ingenious process these spectra are separated, the red of the 6th order spectrum falling below the yellow of the 7th, and this underneath the green of the 8th; while above this green lies the blue of the 9th order, and above that the extreme violet of the 10th.

This separation may be effected by the direct-vision prism of the observing telescope, but less perfectly.—4 *D, June*, 1876, 429.

THE THIRD RADCLIFFE CATALOGUE OF STARS.

We learn from the report for 1876 of the Rev. Robert Main, Radcliffe observer at Oxford, that the preliminary work for the compilation of the Third Radcliffe Catalogue has been begun. It will contain about 4000 stars, the result of nine years' (1862–1870 inclusive) observations. Particular attention has been given to those stars of the British Association Catalogue whose positions are imperfectly determined.

For the year June, 1875, to June, 1876, there were observed 2303 transits and 3471 zenith distances of 1187 stars. The sun was observed on the meridian 100 times, the moon 51 times, *Mercury* 34 times, *Venus* 17 times, *Mars* 5 times, *Jupiter* 24 times, *Saturn* 14 times, *Uranus* 5 times, and *Neptune* twice.

LUNAR MAPS.

Besides the well-known map of Beer and Mädler, there have been several attempts to portray the features of the moon's surface. Of these no one is probably more accurate than that of Lohrmann, a portion of which was published in fine steel engraving in 1824. Barth, of Leipzig, is now publishing the remainder of this map, which will be three feet in diameter. A descriptive letter-press is to be furnished by Schmidt, of Athens. At the same time Schmidt is editing his own work, which will be embodied in a map six French feet in diameter, which the Prussian government has pur-

chased. This last is the result of thirty-four years' work, and contains about 34,000 craters and an equal number of hills, besides other objects. It is to be explained by a suitable text. Work upon Birt's map, formerly prosecuted by aid of the British Association's funds, is for the present suspended. It is to be hoped that this may one day be completed. —12 *A*, *May* 18, 1876.

SUPPOSED OBSERVATION OF AN INTER-MERCURIAL PLANET.

M. Weber, of Peckeloh, observed on the 4th of April, 1876, about 4^h, a round spot on the sun which was not there on the morning of that day, and which had disappeared on the morning of the 5th. It is somewhat curious, as pointed out by Dr. Wolf, of Zurich, who communicates the observation to Le Verrier, that this observation is 6219 days $=148 \times 42.02$ days after that of Lescarbault, as 42 days seems to be the period indicated by former observations (?) of this supposititious planet. Thus the observations of Steinhübel (1820), Pons (1823), Stark (1826), Capocci (1845), Schmidt (1847), Ohrt (1857), and Lescarbault (1859), seem to indicate a period of 42 days, the separate results ranging from 42.07 to 41.95. From Lescarbault's observation alone Le Verrier deduced a period of about 19 days.—6 *B*, *Aug.* 28, 1876, 510.

GLASS DIVIDED CIRCLES FOR THE MEASUREMENT OF ANGLES.

Mr. Lewis M. Rutherfurd publishes in the *American Journal of Science* for August, 1876, an account of a circle divided on glass which he has had fitted to his spectrometer. It is ten inches in diameter, divided to ten minutes of arc, and read by two microscopes magnifying seventy-five diameters to single seconds. A second on such a circle is about one forty-thousandth of an inch, but such was the fineness of the lines of division that the probable accidental error of pointing was considerably less than half a second of arc. Mr. Rutherfurd is of the opinion that on glass circles so divided and of fifteen inches in diameter, more accurate work could be done than upon the metal circles (thirty-six inches and upward in diameter) now in use in large astronomical instruments. "The advantages of this system are obvious: perfection of surface, permitting a line of any desired fineness; facility of illumination, permitting the extension of the

power of the reading microscopes to several hundred times; smallness of dimensions, and consequent cheapness; and avoidance of almost all the questions of flexure and local effects of temperature."

CINCINNATI CATALOGUE OF NEW DOUBLE STARS.

The Cincinnati Observatory has just published in a neat octavo form a catalogue of fifty new double stars, discovered with the 11-inch refractor, by H. A. Howe, with the places of the stars for 1880.0. The pages are well arranged, every thing relating to the *position* of the star being on the left-hand page, and the *position-angle*, *distance*, and *magnitudes* of the doubles, with the date of discovery and remarks, being opposite, on the right-hand page.

The stars are mostly small, and all are below the sixth magnitude; but, on the other hand, the pairs are close, no less than twenty-one out of the fifty pairs being two seconds of arc or less in distance, and none greater than eight seconds. Most of them are also very far south, in a field comparatively unworked before.

LIST OF LATITUDE STARS EMPLOYED IN THE COAST SURVEY.

It has heretofore been the custom in the Coast Survey to determine the latitudes of the various astronomical stations by means of pairs of stars selected from the catalogue of the British Association, for observation by Talcott's method. These pairs were observed in the field, and the note-books sent to Washington, where the final reductions were made. The declinations for the observed stars were obtained from a comparison of good modern authorities, such as the publications of the observatories of Greenwich, Washington, Radcliffe, and Armagh. In many cases the observatories of Washington and of Cambridge, Mass., have determined the declinations specially. The Coast Survey has selected from the "Durchmusterung" all stars between the declinations of $+88° 40'$ and $-1° 48'$, and above the 5.9 magnitude, 2164 in all, and has published in its report for 1873 a list of these, with the approximate places for 1880.0.

It is further intended to publish shortly accurate places of all these stars, so that a complete working catalogue of nearly all the naked-eye stars of the northern hemisphere will be

available. The list was selected under the direction of Assistant C. S. Peirce, who has also given much attention to the determination of the magnitudes. This list has been carefully compared with the catalogue of Heis, with the result of detecting a very large number of errata, a list of which forms a supplement to the catalogue of great value. The catalogue has seven columns: 1. The current number from 1 to 2164; 2. The number in the B. A. C.; 3. The usual designation by constellations; 4. The magnitudes as assigned by Mr. Peirce; 5 and 6. The approximate R. A. and δ for 1880.0; and 7. Synonyms and references to other authorities than the B. A. C.

SPECTRUM OBSERVATIONS OF THE STARS.

M. D'Arrest, the Director of the Observatory at Copenhagen, writes that he continues to devote the powers of his large telescope to celestial spectroscopy. His "Durchmusterung," or spectroscopic examination of the stars in the northern heavens, continues to increase the number of stellar spectra which belong to the third class in a far larger proportion than any other of Secchi's four divisions. The stars of this type afford remarkable objects for investigation, and are pretty numerously and uniformly distributed throughout the heavens. Only a few other spectra have striking similarities among themselves. In some the position and the groups of dark absorption bands are, as Secchi and Vogel have stated, in complete accordance. Groups occur in which even the various intensities of the bright lines are sometimes alike; these lines being, in general, brightest near the red end, although frequently exhibiting uniform brightness throughout the spectrum. But there is a remarkable uniformity in all the spectra. Out of 11,000 stars whose light has been thus examined, only eighty spectra offer characteristics worthy of special mention, and only five new stars are found whose spectra belong to the fourth class. On the average, therefore, where there is one star of the third class for every 140 stars examined, there is but one star of the fourth class for every 1000; and this holds throughout for all stars brighter than the eighth magnitude. In bright stars of the third type, dark absorption bands have several times been perceived. Only once, says D'Arrest, has he found a

star of the sixth magnitude with distinct bands, departing in this respect from the characteristics of both the third and the fourth types, in which case, however, a short examination revealed to him that he was examining the planet Uranus, and not a fixed star. Twice in the course of his sweeps among the stars has he thus, with his small instrument, spectroscopically discovered this planet.—*Astr. Nach.*, LXXXV., 250.

THE RESISTING MEDIUM EXISTING IN SPACE.

The argument for the existence of a medium in the interstellar spaces which is sufficiently dense to affect the movements of the planets, comets, etc., has for a long time been based solely upon the supposed retardation of the movements of Encke's comet. This body completes its orbit around the sun in about three years, but has of late always appeared so exceedingly faint as to be invisible except in the most powerful telescopes. The accurate computations of Von Asten having shown him that the movements of this body, as observed during the last ten years, could be accurately accounted for by a careful computation of the disturbing attractions of the planets, he was led to predict the positions in which the comet should appear during the spring of 1875, in which predictions no allowance was made for the resistance offered to its motion by Encke's hypothetical ethereal medium. The first glimpse of the comet during that season was obtained by the observers at Washington in charge of the great equatorial. According to these and other astronomers, the comet passed in the heavens through a path so nearly accordant with Von Asten's predictions as to show that to account for its motion during the last two or three apparitions no recourse to the notion of a resisting medium is necessary. Further investigations on this comet are in progress.—7 *C*, XL., 45.

MOTION OF THE SOLAR SYSTEM IN SPACE.

In a recent contribution to the study of the motion of the solar system in space, Professor Safford, of Chicago, states that his investigation is based upon the movements of the 250 stars examined by Argelander, for nearly all of which we have very accurate determinations of the proper motions,

while only six or seven of them have been previously used in the similar investigations of Argelander, Mädler, O. Struve, Airy, Main, and others. In studying these stars, Professor Safford states that he grouped them by tens, assuming those to be equally distant whose proper motions in arc were nearly equal, and therefore leaving entirely out of consideration the brightness of the stars. His first result, as regards the direction of the movement of the solar system, was not very different from those of his predecessors; but there appeared indications that, for each of his groups of stars, the average proper motion was inversely proportioned to the average distance; in other words, that our assumption of stellar distances ought to depend upon proper motions. He concludes that the stars having similar motions especially need study at this time, and that eventually we may hope to use the solar motion as a sort of base to advance our knowledge of stellar distances. This will be accomplished so soon as we know the values of all the parallaxes that amount to or exceed one second; and this may be soon determined by systematic co-operative arrangements among the astronomers of the world.—*Proc. Am. Acad. Arts and Sci.*, 1875, 82.

EXACT OBSERVATIONS OF NEBULÆ.

Dr. Schultz, of Upsala, has during the past ten years devoted a great deal of attention to the observation of nebulæ, having special reference to the determination of their precise positions and motions. The results of his observations have been published as a catalogue of 500 nebulæ, the whole number of single measures amounting to 12,000, a number which is large enough to assure us of his great devotion to the work. The heavens at Upsala are rarely free from clouds for any length of time; and the long twilights of summer, the regular recurrence of bright moonlights, and the frequent brilliant auroræ, have all combined to leave him but 404 working nights (or one night in ten in the course of eleven years) that could be utilized for his delicate measurements. The large number of auroræ noticed by him will be an important minor result of his persistent labors. The telescope employed by Dr. Schultz was of thirteen feet focal length, whence we may gather that similar desirable work is fully within reach of a number of telescopes in the United States.

PUBLICATIONS OF THE OBSERVATORY OF BOTHKAMP.

The private observatory of the Councilor von Bülow, at Bothkamp, has just published its third volume of "Observations," under the editorship of Dr. O. Löhse, astronomer of the observatory, and announces the speedy issue of a fourth volume. The present volume is devoted to physical investigations on the nature of the sun's surface, to the registration of solar spots, and to the study of solar spots, faculæ, etc. It is illustrated with plates of solar spots, etc., and we note that one of the large spots drawn is the same already studied by M. Trouvelot, a drawing of which was published by Professor Winlock in the astronomical engravings from Harvard College Observatory. The observatory of Herr von Bülow was the first one in Germany to be devoted solely to celestial physics, and its great success may have had much to do with the establishment of the *Astrophysikalischen Institut*, at Potsdam, by the Prussian government.

THE SOLAR PARALLAX.

Professor Galle, who has endeavored to calculate the solar parallax from observations of the asteroid Flora, announced as the final result of his computations 8.879″ as deduced from 36 southern and 37 northern stars, the distribution of the comparison stars being as favorable to an accurate result as is possible. The greatest probable error that we can ascribe to this result is the one twenty-fifth of a second. But it is very remarkable, if we divide his seventy-three equations into three sections of twenty-four or twenty-five observations each, that we deduce the following values, viz.: 8.96″, 8.86″, and 8.78″. The whole computation will at some future time be published in full; but Professor Galle states that he has come to the conclusion that so accurate a result with so small a probable error could only have been accomplished by the kind co-operation of the observatories of the southern hemisphere, and that even a still better approximation can perhaps by this method be attained in the future. To this end the observations should, if ever repeated, be made with the largest telescopes, using the highest magnifying powers. As constant errors can be eliminated by a proper arrangement of the observations of the stars of compar-

ison, it becomes more important to diminish the effect of accidental errors by a large increase in the number of observations. It is interesting to add that the preliminary results of the observations of the recent transit of Venus, as presented to the Paris Academy of Science, agreed completely with the figures deduced by Dr. Galle.—*Astr. Nach.*, LXXXV., 270.

PRIZES PROPOSED FOR ASTRONOMICAL WORKS IN 1876.

The French Academy of Sciences announces that in 1876 it will give, besides the Lalande medal, a prize (the Damoiseau prize) for the best memoir on the following subject: "Revise the theory of the satellites of Jupiter: discuss the observations, and deduce the constants which depend upon them; especially determine the velocity of light; finally, construct special tables for each satellite."—6 *B, Dec.* 22, 1875, 1376.

THE LALANDE PRIZE.

The Lalande prize of the French Academy is given yearly to the astronomer who shall publish the most useful memoir or make the most important observation. This has been awarded for 1875 to M. Perrotin, of the Observatory of Toulouse, for his astronomical observations, and particularly for his discovery of asteroids. The brothers Henry, of Paris, and MM. Borelly and Coggia, of Marseilles, have received this medal in previous years for the same kind of labors, as has also Professor Watson, of Michigan University.—6 *B, Dec.* 22, 1875, 1311.

THE INNER SATELLITES OF URANUS.

These objects, which were discovered by Lassell with his two-foot reflector, have lately been the subject of some discussion. In *Mon. Not. R. A. S.* (vol. xxxv., p. 16), Professor Holden, of the Naval Observatory, advanced the opinion, after a comparison of William Herschel's observations of small objects near Uranus in 1789–1815 with tables of the motion of these bodies (published by Professor Newcomb of the same observatory, in the "Washington Astronomical Observations for 1873," Appendix I.), that William Herschel had really seen both Ariel and Umbriel, and that he had observed them.

Lassell, in the same number of the *Monthly Notices*, disputed the evidence adduced, and claimed that not only was he the discoverer of the very faint bodies, but that he first saw them. Both Professor Newcomb (op. cit., p. 43) and Professor Holden doubted the reality of some observations of Ariel made by Dr. Vogel at Bothkamp with a telescope of 12 inches aperture, and published in the "Bothkamp Observations," vol. i., on account of the extreme faintness of these bodies even in the much larger telescope of the Naval Observatory (26 inches). Dr. Vogel has published in the *Astronomische Nachrichten* (bd. 87, col. 52) other observations of objects near Uranus, made in 1871, some of which agree well with the ephemeris by Mr. Marth. From this he concludes, with strong probability, that under some circumstances Ariel and Umbriel (the inner satellites) can be seen with a telescope of no more than 12 inches aperture. Since the publication of this paper Professor Holden has been able to see the inner satellites with an aperture of 15 inches on the Washington equatorial.

FUNDAMENTAL STARS OBSERVED AT HARVARD COLLEGE OBSERVATORY.

To meet the demand for a greater number of polar and clock stars, Professor Winlock, Director of the Harvard College Observatory, began in 1872 a series of observations with the new meridian circle upon a list of 373 polar and clock stars (148 of less than 30° of N. P. D.). These observations were made in 1872–3 by Mr. William A. Rogers, assistant, and the right ascensions are published in *Astronomische Nachrichten*, bd. 87, col. 67. The new Oxford Observatory has also undertaken, under the direction of Professor Pritchard, a work of this kind.

SOLAR SPOTS.

Gauthier states that as the results of three and a half years of observations on the solar phenomena, by means of the equatorial of the observatory at Geneva, kindly put at his disposition by Professor Plantamour, he finds himself entirely justified in coinciding perfectly with the theory of Zöllner as to solar spots being scoriæ floating upon the liquid, and possibly even within the denser gaseous portion of the solar

surface. They are apparently the result of cooling, depending on the radiation from the surface of the sun; and this explanation by Zöllner is the only one that seems to him not to contradict both ordinary laws of physics and well-known facts.

VARIABLE STARS U, W, AND X SAGITTARII.

Dr. Julius Schmidt, Director of the Athens Observatory, has lately published the results of his investigations on the variable stars U, W, and X *Sagittarii*. The variations observed in their brightness are of a similar character, as they all have periods in the neighborhood of seven days. These periods, however, are complicated by longer subsidiary cycles of three and a half, eight, and two years respectively. In each case the *increase* in light is more rapid than the *decrease*, the progress from a minimum to the next maximum requiring about three days, and from this maximum to the next minimum about four days. In W *Sagittarii* there is a well-marked secondary maximum and minimum.

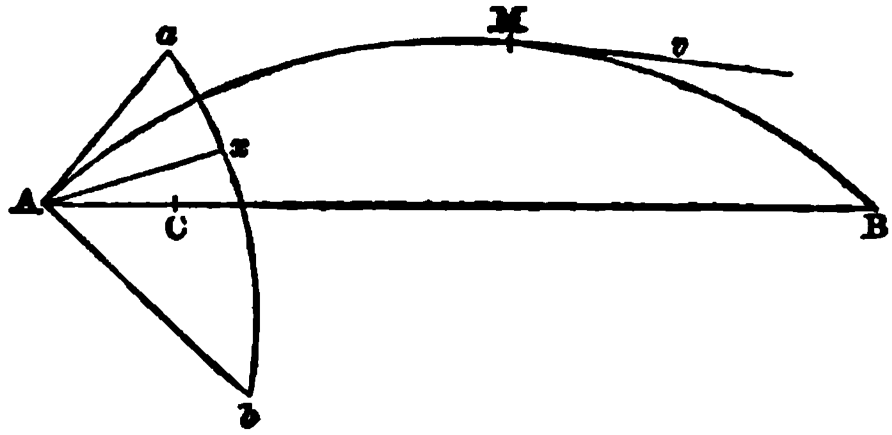
No adequate physical causes for these changes have yet been assigned. A still more remarkable and inexplicable case of variation has been investigated by Dr. Schmidt in U *Herculis*. The period of this star is between thirty-eight and forty days, but secondary changes having a period of about twelve hours occur throughout a large portion of the main cycle certainly, and possibly throughout the whole duration. These secondary changes are large in amount for the eight or ten days near each minimum, but quite small near the maxima.—38 *C*, Nos. 2071 and 2075.

SOMOFF'S BARYCENTRIC THEOREM.

Somoff has presented a note to the Academy of Sciences at St. Petersburg on a barycentric theorem discovered by him, and which offers an elegant method of expressing the duration of any movement whatever of a point with reference to two right lines. The theorem may be enunciated as follows:

Let T be the duration of any movement whatever of a point, M; and let the curved line AMB be that described during the time T; AB will be the chord that limits the space AMB. Put v for the velocity acquired by the body,

M, at any moment, t. Let Ax be a variable line that, starting always from A, remains during the whole time, T, equal and parallel to the velocity, v, and pointing in the same direction. Finally, let ab be the arc described by x during the interval T; that is to say, ab will be the hodograph of the velocity, v.



Conceive now any mass so distributed along ab that the density at the point x shall be in the inverse ratio of the force which solicits the point M, or of the acceleration of the first order.

It can now be shown that the centre of gravity, C, of this mass lies on the chord AB, and that the ratio $\frac{AB}{AC}$ is equal to the duration T. We may, therefore, consider the line AC in length and direction as the mean of the velocities which the projection of M upon the chord AB acquires during the time T.—*Bull. Acad. Sci. of St. Petersburg*, 1874, 258.

THE SOLAR SPOTS AND PROTUBERANCES OF THE SUN FROM 1871 TO 1875.

Father Secchi, in giving a review of his observations on the solar spots and protuberances for the past four years, states that they extend over about fifty-two rotations of the sun upon its own axis (or solar days). The average number of protuberances observed each day, which was about fifteen in 1871, was reduced to from four to ten in 1870, the average of the whole period being about ten, and the progressive diminution being very regular. The area covered by the protuberances was reduced in a similar proportion, viz., from fifteen to five. In 1871 the average number of groups of spots was about twenty-five, which number was reduced to six or seven in 1875. The surface covered by the spots has diminished to ten in 1875, being ninety in 1871. It is evident that the solar activity, as far as manifested by the quantity of spots, corresponds to the activity presented by the protuberances. The parallelism is not absolute, however, nor could this be expected, since certain protuberances,

being purely hydrogen, have nothing to do with these solar spots. In consequence of this being a year of minimum of solar spots and protuberances, Father Secchi thinks he finds therein the explanation of Professor Langley's result, since the latter gentleman has observed that at present there is no difference of temperature between the sun's equator and its poles.—6 *B*, LXXX., 1273.

THE SOLAR OBSERVATORY AT POTSDAM.

Some account of the new German solar observatory established at Potsdam, near Berlin, is given in Klein's *Wochenschrift*, from which we gather that this institution is situated upon a considerable elevation, and will consist of a group of several isolated observing domes, each to contain its own telescope. Of these domes, the southern one, having a telescope of eleven inches aperture, will be devoted to spectrum analysis, which observations will be applied also to the stars as well as the sun. In another dome the heliograph will be established, which will be devoted also to the photography of the sun, and possibly of the moon and stars. The western dome will contain a telescope of eight inches aperture for special investigations of sun spots and protuberances. The eastern dome will contain the telescope of seventeen feet focal length now employed by Professor Sporer for the study of the protuberances. North of these domes will be the principal building, devoted to optical, physical, and chemical researches, and north of it will be rooms for the assistants, micrometric apparatus, etc. Still north of this building will be one containing a large tank of water, in whose cellar magnetic apparatus will be established.

At the depth of one hundred feet under the ground a space will be provided for erecting a Zöllner's horizontal pendulum. Finally, the dwelling-houses are to be mentioned, which will accommodate quite a number of observers and officials. In connection with the prosecution of Professor Sporer's observations of sun spots and protuberances, it is stated that one of the most brilliant protuberances recently appeared in the polar region of the sun, where they are generally wanting. It shot forth in nineteen minutes, and indicated with certainty the presence of a violent storm at that point.—*Klein's Wochenschrift*, 1875, 249.

SPECTROSCOPIC DIAMETER OF THE SUN.

At the recent meeting of Italian astronomers, experiments were made by Secchi, Tacchini, Rayet, and Dorna to determine the difference between the diameter of the sun as determined by the spectroscope and by the method of meridian transits. From the observations of ten days the spectroscopic semi-diameter was *less* than the transit semi-diameter by 0.124″, and *less* than the Nautical Almanac semi-diameter by 0.104″. Atmospheric conditions were found to be influential in these determinations.—2 *G*, *November*, 1875, 118.

IDENTITY OF COMET VII., 1873 (COGGIA), WITH COMET I., 1818 (PONS).

Dr. Weiss, of the Vienna Observatory, has investigated the orbit of the comet discovered by Coggia the 10th of November, 1873. As he has previously shown, there is scarcely a doubt that this comet is identical with the comet discovered by Pons in 1818, and in this case the determination of the period of revolution is quite important. Dr. Weiss finds that there are three possible periods, viz., 55.82 years, 18.61 years, and 6.20 years. Of these three, the second is the least probable; and of the first and third, Dr. Weiss considers the period of 6.20 years the most probable for the present, although his computations are to be carried farther as soon as he shall have received further observations of this body during its last appearance.—38 *C*, No. 2072.

A NEW MERIDIAN INSTRUMENT AT THE OBSERVATORY AT RIO.

M. Liais, Director of the Observatory of Rio, describes a new arrangement of his mural circle (made by Dollond), which is intended to convert it into an instrument suitable for determining right ascensions. Within the tube of the mural-circle telescope, M, is fixed a plane mirror, which is perpendicular to the axis of rotation of the mural circle. At ten feet from the circle, and looking toward it, is a telescope with high magnifying power, A. Close to A is a mark (*mire*) which can be moved either vertically or horizontally by means of two micrometer screws of known value. If M is in any given position, the mark can be placed, by means of

its micrometer screws, so as to be seen on the cross-threads in the focus of A. If the mirror is truly perpendicular to the axis of the mural circle, and that axis is perfectly regular, the telescope, M, might be turned in any position, and the mark would still be on the cross-threads of A. If, however, in a given position of M the mark is *not* on these threads, the micrometer screws of the mark will serve to bring it back to these threads, and in this way it may be determined how far the normal to the surface of the mirror is displaced horizontally and vertically for each position of M. In this way the position of M may be referred to a vertical plane passing through the north and south collimators of the mural circle. The ordinary formulæ for the transit instrument will serve for this purpose if, first, the angle formed by the optical axis of M with the fixed vertical plane (if the mirror is put into that plane) be substituted for the error of collimation; second, if for the error of azimuth be substituted the angle between the vertical plane through the normal to the mirror and the vertical plane perpendicular to the plane of reference; third, if for the error of inclination be substituted the angle between the normal to the mirror and the horizon.

These quantities can be determined from the micrometers of the mark, first, when the telescope, M, is directed on the two collimators, and, second, when directed to the star observed. In this way the observations are reduced to the plane of reference, and this can be referred in the ordinary way to the meridian.

The south collimator at Rio is a mark in the focus of a long-focused objective. The north collimator is the axis of the prime vertical transit instrument, which is itself provided with collimators. Thus the meridian instruments of this observatory form one connected system. The device of Liais serves also to investigate the flexure of the telescope M.—6 *B*, LXXXII., *February* 28, 1876, 495.

THE SOLAR ECLIPSE OF APRIL 16, 1874.

Mr. E. J. Stone, Astronomer Royal at the Cape of Good Hope, observed the total solar eclipse of April 16, 1874, at Klipfontain, Africa, fifty-five miles from the coast. Mr. Stone's plan of campaign was necessarily simple, as the difficulties of travel in South Africa prevented the transpor-

tation of delicate appliances, but the points to which he directed his attention were, although few, perfectly definite. By circulars distributed throughout the colony, instructions were communicated as to the proper methods of making drawings of the corona, and several important drawings were received, which are carefully studied by Mr. Stone. They exhibit the usual marked discrepancies in most cases, notably in two made by two expert draughtsmen seated side by side at the same table; but Mr. Stone gives a satisfactory explanation of the differences here, which may serve to account for similar discrepancies in former drawings. Mr. Stone summarizes the results of his expedition as follows:

"1. A confirmation of Young's observation of the general, or nearly general, reversion of the Fraunhofer lines in the spectrum of the corona near the photosphere.

"2. A spectroscopic examination of the outer corona, in contradistinction to the inner corona, carried to the extent of rather more than a degree from the sun's centre, which has proved that the spectrum of the outer corona consists of a linear spectrum of one bright line, either exclusively or sensibly, whose wave length is 5.312, with a unit of one tenth of a meter, and of an ordinary sunlight spectrum with absorption lines. The spectrum of the outer corona has been shown to fade gradually away, as the extreme visible limit of the corona is approached, and not to disappear sharply, as if the extreme limit of the corona had been reached.

"3. The spectroscopic examination of the outer corona, combined with the unchanged character of its principal features, as seen at [three different observing stations] at intervals of absolute time extending to ten minutes, and at distances of more than 500 miles, proves, I venture to think, the solar origin and cosmical character of the outer corona. . . .

"4. A comparison of the drawing of Mr. Henry Hall . . . and the photographs obtained in 1869 and 1871, shows the permanent character of the contraction of the inner corona in a direction parallel or nearly parallel to the sun's axis of rotation. The strongly marked character of the general contraction of the outer corona in the same direction may not improbably ultimately lead to a similar inference in the case of the outer corona also."—*Memoirs Royal Astronomical Society*, XL., 11.

PHOTOGRAPHS OF THE SOLAR CORONA.

Professor Zenger, of Prague, announces a success which, if confirmed, will be of high importance. By using a new form of "achromatic lens in combination with mirrors of large aperture and very short focal length, so as to reduce the focal length to four times the aperture," Professor Zenger claims to have photographed the solar corona with the protuberances on it, and also to have examined the corona through the telescope. He describes its appearance to the eye as "a bright circular ring . . . on an average one minute in height, and only in exceptional cases of nearly two minutes, and an eccentricity amounting to only two or three seconds of arc."

DISTRIBUTION OF PUBLIC TIME.

The importance of this subject, which is now attracting general attention, will render the subjoined list of the various time-balls, time-guns, etc., of the world, valuable. It has been compiled from the best sources available, but corrections and additions will no doubt be necessary in many cases, as the materials for the compilation are somewhat limited.

List of Time-balls, Time-signals, etc.

EUROPE.

Helsingfors.—There is a time-ball dropped at noon at the observatory, and a gun fired either on the guard-ship or ashore.

Bergen.—A time-ball is dropped daily at noon.

St. Petersburg.—Several public clocks in the city are controlled from the Pulkova Observatory, and a time-ball (*or* time-gun) makes a signal at noon daily.

Kiel.—Time-ball (*or* time-gun) for shipping.

Dantzig.—Time-ball at local noon and at Greenwich 1^h.

Hamburg.—Time-ball (*or* time-gun) for shipping.

Paris.—The public clocks are controlled from the Paris Observatory.

Lisbon.—A time-ball is dropped from the observatory at 1^h Lisbon mean time, and one is dropped simultaneously on the south side of the river from Prayal flag-staff.

Cadiz.—A time-ball is established at Cadiz, but we have no information of the time at which it is dropped.

Neuchâtel.—An extensive system of electrically controlled clocks and of time-signals radiates from this observatory, for the purpose of giving the true time to the chronometer and watch makers, and for the public convenience. Several towns participate in this.

AFRICA.

Cape of Good Hope.—Time-ball at 1^h.

ASIA, ETC.

Madras.—A time-ball is dropped daily from the Custom-house at $8^h\ 20^m\ 57.3^s$ Madras mean [civil] time=15^h Greenwich mean time. The time of the flash of the evening gun is noted at the observatory, and published at the Master-Intendant's office the next morning.

Batavia (*Java*).—There is a time-ball dropped at Batavia mean noon, and also one at $1^h\ 7^m\ 12.5^s$ Batavia mean time= 18^h Greenwich mean time. *Calcutta.*—Daily time-gun.

Vladivostok.—There is a branch of the Russian Hydrographic Office established at Vladivostok, and a naval officer obtains the time daily with a transit instrument, and keeps his clock regulated for the benefit of navigators.

AUSTRALIA.

Melbourne.—A time-ball is dropped daily (Sundays excepted) at 1^h m. s. t. The time is also given from the same place at 8^h (P.M.) by the obscuration of a powerful light at two minutes before 8^h: the instant of reappearance of the light is the true time. The errors of these two signals on any day are published on the next day in the newspapers.

Sydney.—A time-ball is dropped daily.

Newcastle.—A time-ball is dropped daily by signals from Sydney.

SOUTH AMERICA.

Rio de Janeiro.—We have no entirely satisfactory account of the details, but we are informed that a time-ball is dropped daily at noon.

Buenos Ayres.—The Observatory of Cordoba sends electric signals to Buenos Ayres for the regulation of clocks accessible to ship-masters.

NORTH AMERICA.

St. John's (New Brunswick).—Time-ball daily (except Sunday) at one o'clock, by a chronometer which is compared with a clock rated by a transit instrument.

Quebec.—A time-ball is dropped for the shipping at 1^h, and a time-gun fired in the city for public convenience at noon.

Kingston (Canada).—Time is given to the city and to the shipping daily from the observatory.

Ontario.—For the past four years the observatory has struck its time-signals on the fire-alarm bells.

Pittsburgh.—The City-hall clock is controlled from the Alleghany Observatory, and the fire-alarm bells are struck at noon and at every third hour. Time is furnished to the Pennsylvania Railway.

Cincinnati.—The clock on the City-hall is controlled by electric signals every two seconds, and the fire-alarm bells are struck at noon.

Cambridge and Boston.—For some years the Harvard College Observatory has controlled clocks in Boston, and furnished standard time to some of the railways.

Albany.—It is understood that the Dudley Observatory furnishes time to the city of Albany and to the Hudson River Railway.

Chicago.—Time is given to the city from the Dearborn Observatory.

Washington.—A time-ball is dropped daily (Sundays excepted) at noon. Clocks in the city are controlled (on Jones's system) at the Navy Department, State Department, Treasury Department, Signal-office, and one is proposed for erection at the Western Union Telegraph Office. Daily (except Sundays) at noon a signal is sent from the observatory to the Washington office of the Western Union Telegraph Company, and by them distributed over such of their wires as may be unemployed. Practically this signal *always* reaches Philadelphia and New York, and Chicago, Cincinnati, and St. Louis very often. The fire-alarm bells are struck at 7 A.M., 12 M., and 6 P.M.

GREAT BRITAIN.

Glasgow.—The wire formerly owned by the observatory has been transferred to the government telegraphs, which distributes the time-signals to the public at very low rates: for example, £1 yearly is charged for a clock controlled within one third of a mile of the office, etc.

Liverpool.—A time-ball is dropped daily at 1^h visible to the shipping, a time-gun is fired at the same hour at the Morpeth Dock pier-head; the clock in the Victoria Tower (six dials) is controlled, as well as several clocks in the city.

Edinburgh.—A time-ball, visible to the shipping in the Firth, is dropped daily from Nelson's Monument on the Calton Hill, a gun is fired from the Castle, and numerous clocks are electrically controlled, some of them being exposed for the convenience of the public. Time is sent daily to Dundee.

Dun Echt.—At Lord Lindsay's private observatory at Dun Echt, near Aberdeen, a time-gun is fired daily for the public convenience.

Dundee.—Signals are received daily from Edinburgh at an expense of £100 per year, and a time-gun is fired automatically.

Deal.—A time-ball is dropped at 1^h from Greenwich.

Portsmouth and Start-Point.—Time-balls (at 1^h) are proposed.

Dublin.—Greenwich time-signal is received daily at 10^h A.M., and distributed. We are not informed as to details.

Belfast.—Greenwich time-signal at 10 A.M.

Guernsey.— " " " "

Newcastle.—Time-gun automatically fired at 1^h Greenwich time.

Sunderland.— " " " " "

Middlesboro'.— " " " " "

Kendal.— " " " " "

Norwich.—Greenwich time is distributed.

Stockton.— " " " "

Worcester.— " " " "

Nottingham.— " " " "

Devonport.—Time-balls are dropped on Mount Wise at 1^h and at $1^h\ 5^m$ Greenwich mean time.

Greenwich.—A time-ball is dropped daily at 1 P.M.; a ball is automatically dropped at Deal. Time-balls are proposed for Portsmouth and Start-Point. Hourly currents are sent from the observatory to the Post-office, from which they are distributed to subscribers. Currents are sent automatically at 10 A.M. and 1 P.M., and widely distributed; and almost daily signals are sent directly to about 600 places, including railway termini, and from these places they are repeated to the lines radiating therefrom. The system is practically complete.

VISIBILITY OF STARS IN THE DAY-TIME.

Dr. Rudolf Wolf communicates to the Philosophical Society of Zurich (20th year, page 179) a note on the visibility of stars in the day-time from the bottom of deep wells. It appears that Mr. F. Carpentier, of Zurich, tried the experiment of looking for stars in the day-time from the bottom of a deep well (ninety feet), and that he was successful. It was done when the experimenter was but a lad, and although there is no doubt as to the fact, the names of the stars seen and the particulars of the observation can not be recovered.

MEASURE OF TIME BY HOUR-GLASSES.

Dr. Wolf, of Zurich, having occasion to use an hour-glass which was intended to mark half-hours, endeavored to determine the probable error of a measure made by means of this instrument. The ending of the flow of sand could be observed quite exactly, *i. e.*, to within one second of time; the mean of sixty trials gave him for the time of flow $28^m\ 29.95^s \pm 5.7^s$. The probable error of a single observation was no less than 43.9 seconds. It thus appears that this instrument, which was extensively used by the ancients, is not a trustworthy one for exact determinations.

B. TERRESTRIAL PHYSICS AND METEOROLOGY.

MECHANICAL THEORY OF OCEAN CURRENTS.

The application of mathematics and the laws of mechanics to the theoretical investigations of the currents of the atmosphere and the ocean, with which subject American students have become so familiar through the labors of Professor Ferrel, has of late years been taken up quite energetically in Europe; and to the labors of Colding, Peslin, Everett, Thomson, Hann, and others, we now have to add the somewhat elementary memoir of Professor Blazek on the elements of a mechanical theory of the ocean currents, which communication is, he implies, introductory to a more extended memoir that may be expected from him. He considers that every particle of water is actuated by two forces—that of gravity toward the centre of the earth, and the centrifugal force due to the daily rotation of the earth. The centrifugal force in and of itself can produce no constant current, since it is in obedience to it that the earth owes its permanent ellipsoidal shape; but if on such an ellipsoid the temperature in general diminishes toward the equator and toward the two poles, there results a tendency toward a new distribution of the mass of the water, which therefore demands a new figure of equilibrium. The dense, cold waters of the two polar seas, therefore, flow toward the equator, while the lighter warm waters flow from the equator toward either pole. Less water flows from regions of low temperature toward the regions of high temperature, and the northern hemisphere sends to the equator less cold water than the southern hemisphere. Consequently, as he demonstrates, the centres of all the closed portions of the equatorial currents in all oceans are found between the 35th and 30th parallel of latitude. The centrifugal force drives the cold water toward the equator and the warm water toward the polar regions, and in consequence of the earth's rotation these latitudinal currents are turned aside—those from the poles to the west, and those from the equator to the east.—*Sitzb. K. Böhm. Gesell.*, 1874, 195.

THE TEMPERATURE OF THE SEA.

Observations on the temperature of the sea have been made at Falmouth, England, continually since the autumn of 1871. It was at first proposed to make the observations about the time of high water in Falmouth harbor, it being thought that, owing to the great extent and depth of the harbor, the influence of the shore would not be felt when the water had freshly come in from the open sea. But it soon became apparent that results obtained in the harbor and near the shore were worthless. Experiments proved that differences of several degrees of temperature existed within very small limits of space; and Mr. Dymond, by whom the observations had been made, states that he has reason to think that observations on the temperature of the sea are, in general, of little or no value unless they are made from a vessel considerably outside of low-water mark. It was therefore determined, within a few months after the observations were begun, to make them in the open sea, at distances varying from half a mile to three or more miles from the nearest land. During the three years—1872, 3, and 4—observations were made on 747 days; and the mean of all these readings is 53.23°, while the mean of the 36 highest and 36 lowest monthly readings is 53.25°. The monthly range of the sea temperatures varied from 2° in March to 6.5° in July. The importance of making similar investigations at other stations where sea temperatures are systematically observed is forcibly suggested by this result of Mr. Dymond's studies, and it is evidently highly desirable that the light-ships stationed along our coasts should be utilized, whenever possible, for the purpose of observing sea temperatures.—*Forty-second Annual Rep. Royal Cornwall Pol. Society*, p. 105.

ORIGIN OF VOLCANIC ASHES.

Professor Von Roth communicates to the Berlin Academy of Sciences an investigation into the origin of the volcanic ashes that fell in Scandinavia on the 29th and 30th of March. He shows that these were the product of the great volcanic outbreak in the eastern half of Iceland at Vatna, as well as in the Dynqu Mountains.—*Monatsber. Berlin Acad. der Wiss.*, 1875, 256.

ABNORMAL DEFLECTIONS OF THE PLUMB-LINE.

Lieutenant F. V. Greene, Engineer Corps, U. S. A., has recently discussed the station-errors of the 41 astronomical stations established on the 49th parallel of latitude by the joint commission of English and American engineer officers, for the purpose of marking the boundary-line between the United States and the British possessions. The 41 stations were all observed with the zenith telescope, and of them 19 were observed by the English alone, and the average probable error of the final latitude of a station was $\pm 0.088''$; 17 were observed by the Americans alone, and the probable error of a station established by them was $\pm 0.059''$ (76 observations); and 5 were jointly observed by the two parties, their independent results differing by $0.28''$, $0.27''$, $0.07''$, $0.29''$, and $0.31''$ respectively. The various stations were connected geodetically by the method of tangents and offsets; and the difference between the astronomical and geodetic determinations was assumed to be due to abnormal variations in the local directions of gravity, and was called "station-error."

Sufficiently accurate topographical work was done to enable 200-feet contours to be laid down on the maps. From these contours Lieutenant Greene has calculated A (see table), which is the deflection of the plumb-line produced by all masses above the ground within a radius of ten miles, and B, which is the deflection which would be produced by masses between ten and sixty miles distant. This has been done with reference to each of the 41 stations—a work of no little difficulty—and the results are given in the accompanying table. D is the observed deflection, and $D-(A+B)$ is the outstanding residual and unexplained deflection. These quantities for 37 stations in the Ordnance Survey of Great Britain were $D=2.05''$, and $D-(A+B)=1.35''$. From this it appears that for 29 stations the abnormal phenomena are partially accounted for and in the right direction; for 12 stations the computed deflection is in the wrong direction. The quantity $D=2.15''$ which is to be accounted for is about the same in magnitude as the mean error in latitude ($2.64''$) found by Bessel from a discussion of all the great arcs previously measured, and goes to show that the mean hetero-

geneity of large tracts of the earth's surface is about the same in every part of the earth itself:

Stations.	D.		A.*	B.		D—(A+B).	
	Station Errors. Mean Parallel=0.		Computed Deflections. 1 to 10 miles.	Computed Deflections. 10 to 60 miles.		Unexplained Deflections.	
	″	″	″	″	″	″	″
1.....		−2.31			− .007		−2.30
2.....	+1.52				0	+1.52	
3.....	+2.33				0	+2.33	
4.....	+3.18				− .15	+3.43	
5.....	+3.50				− .23	+3.73	
6.....	+2.95		− .42		− .27	+3.64	
7.....	+2.22		− .09		− .46	+2.77	
8.....	+1.40				− .36	+1.76	
9.....		− .21			− .54	+ .33	
10.....		−1.78	− .09		−1.16		− .53
11.....		− .78	− .15		− .74	+ .11	
12.....	+ .06				− .65	+ .71	
13.....		− .30			− .46	+ .16	
14.....		−1.91			− .63		−1.28
15.....		−2.23			− .83		−1.40
16.....		− .50			− .92	+ .42	
17.....		− .31			−1.07	+ .76	
18.....		− .94			− .99	+ .05	
19.....	+1.77				− .38	+2.15	
20.....		−1.91		+ .10			−2.01
21.....		− .81		+ .80			−1.60
22.....	+ .98			+1.50			− .52
23.....		− .76		+1.90			−2.66
24.....	+1.54			+3.29			−1.75
25.....	+2.00			+2.16			− .16
26.....	+3.55			+2.85†		+ .70	
27.....	+3.03			+2.80†		+ .23	
28.....	+1.61			+2.03			− .42
29.....	+5.94			+1.38		+4.56	
30.....	+4.30			+ .99		+3.31	
31.....	+2.09			+ .95		+1.14	
32.....		− .67			−1.43	+ .76	
33.....		−5.32	−2.31		−1.77		−1.24
34.....		−7.95	−7.25		−1.37	+ .62	
35.....		− .67			−1.04	+ .37	
36.....		− .52			−1.00	+ .48	
37.....		−1.17	?	?			
38.....		−3.42	?	?			
39.....		−6.09	?	?			
40.....		−2.42	?	?			
41.....		−1.00	?	?			
Σ......	43.97″	43.98″				36.08″	15.82″
Means..	2.146″					1.442″	

* The stations at which deflections, A, are not computed were situated in the midst of plains, where the deflection, A, would not amount to 0.4″, the uncertainty of the determination of D.

† Carried to 80 miles.

ON THE TEMPERATURE OF THE MEDITERRANEAN SEA NEAR THE COAST OF ALGERIA.

Messrs. Grad and Hagenmüller, in 1872, made a series of observations on the temperature of the water, on the occasion of a voyage along the shores of Algeria, and have continued them at three fixed stations since that year. The mean temperature of the surface through the year is found to vary from 18.3° Centigrade at Algiers, up to 19.5° at Oran; the extremes between winter and summer being 11° and 18° respectively. Observations were made at different depths, down to four meters, at the fixed stations; and by comparison of the Algerine with the Adriatic measurements, it would seem that the isothermal lines on the surface of the Mediterranean bend toward the mouth of the Adriatic Sea, where the temperature is higher during the winter and spring time. —6 *B*, LXXXI., 292.

UNDERGROUND TEMPERATURES.

In some notes on the general facts relating to underground temperature, Mr. Schott states that the earth's solid crust being hotter than the mean temperature of the lower stratum of the atmosphere resting on its surface, heat is constantly and very slowly passing outward, and strata of equal depth would have very nearly uniform temperatures but for the influence of the irregular daily and annual variations of the atmospheric temperature received by conduction. The depth of the stratum of the so-called invariable temperature (viz., where the changes escape ordinary observation, or are less than 0.01° Centigrade) is found about six meters below the surface of the ground in the tropics, and about thirty meters below the surface in the middle latitudes. The depths at which the daily variations become imperceptible are, for these two regions of the globe, respectively 0.3 and 1.3 meters. These numbers, however, depend greatly upon the kind of soil or rock forming the surface, and differ considerably according to the porosity of the loose soil. The mean temperature of the earth's crust increases with increasing depth, and for moderate depths the increase is nearly uniform at the rate of 1° Centigrade for 28 meters. For greater depths, the descent necessary to produce an increase of 1° of temperature is greater

than this figure. The depths at which the daily and annual variations respectively disappear are in the proportion of 1 to 19; or as the square roots of the lengths of the periods. The amplitudes of the daily, annual, or other periodical changes diminish in a geometrical ratio as the depths increase arithmetically. The time required for the heat wave to reach a depth of 7.3 meters at Edinburgh is nearly six months. Therefore the maximum temperature at this depth is synchronous with the minimum temperature at the surface. Mr. Schott computes, from the best data available, what should be the average invariable temperature at the depth of 229 meters underneath Chicago, corresponding to the depth from which water flows in a certain artesian well. The actual temperature observed is only 12.8°. The computed temperature is 16.2°. The explanation of the discrepancy can not be satisfactorily given, unless observations are made upon the influence of the lake water, and the actual rate of increase of temperature at that spot.—*Report Sec. Smithsonian Institution*, 1874, 249.

FORMATION OF BASALT COLUMNS.

Mr. Robert Mallet republishes in full his views on the origin and mechanism of the production of the prismatic or columnar structure of basalt. He states that our knowledge of the mechanism of the jointing of masses of rock is still very far from being complete, but less complete is our knowledge of that which constitutes the complicated systems of joints shown in columnar basalt. The best-known writers are generally at variance on this subject, although the most philosophical views are those that have been defended by Professor James Thomson, now of the University of Glasgow. According to Mr. Mallet's investigations, the primary conditions for the production of straight prismatic structure in basalt are, first, general homogeneity of the material; second, a tolerable regularity in the general form of the mass; third, inequality in the rate of cooling in one or more directions. The more or less horizontal and tabular masses of basalt as they occur in nature are usually cooled most rapidly from their upper or lower faces; or, if the basalt be found filling a dike, then the rapid cooling has taken place on the two opposite surfaces of the dike. When, in conse-

quence of this cooling, the surface of the volume of plastic rock has arrived at that temperature at which its rigidity becomes sufficient to prevent its yielding to the contractile strains in any way except by its splitting up into much smaller surfaces which can draw off from contact with each other, then the principle of least action, or that principle which as a universal law governs every operation of nature by which a given effect is produced with a minimum expenditure of work, comes into play; and in consequence thereof the mass of rock is split up, not into triangular nor into square columns, which might otherwise be possible, but into horizontal prisms. The temperature at which various metallurgic slags and the temperature at which actual lavas lose their plastic or viscous condition and assume sufficient rigidity to break, varies between 900° and 600° Fahr. The prisms thus formed, being cooler at their extremities and warmer in the middle of the mass, are thus subject to strains as the cooling process proceeds which break them up into shorter lengths. These lengths slightly exceed the diameter of the prism and the fracture separating two adjacent lengths must be of a cup-shaped form, as being also the result of the unequal temperature of the mass. In general, the convexity of the cross-joints will point in the reverse direction to that in which the wave of heat has been transmitted from any cooling surface of the mass. The regularity of the shape of the prisms and their joints will be sensibly affected if there be foreign material or empty cavities existing in the mass of the basalt, since these circumstances affect the rate of cooling. Thus in walking over the tops of large pavements of basaltic columns, such as those exposed at the Giant's Causeway and elsewhere, one sees places in which the hexagonal form becomes irregular, and gives place—though for a very small extent of surface—to quadrangular and other irregular forms, sometimes even triangular or wedge-shaped; but passing on a short distance we find these rapidly return to the normal hexagonal type. Curved or bent prisms must also be produced in consequence of those forces that are brought into play when the bounding surfaces supporting the whole mass of cooling basalt are themselves curved. — *Philosophical Magazine, August and September*, 1875.

EARTHQUAKES IN ITALY.

The supplement to the *Meteorologia Italiana* for 1874 contains a memoir by Serpieri on the earthquake of the 12th of March, 1873, concerning which the veteran Alexis Perry says that it has laid the foundation for connecting together in a philosophical manner all the seismic and volcanic phenomena of Italy; and crowning as it does the well-known labors through so many years of Serpieri, it forms a fitting memoir with which to begin the Bulletin of Vulcanology in Italy. In this memoir the author begins by the study of the signification of the records of earthquakes made by self-recording pendulums. Self-registering seismographs have been invented by numerous Italians, to say nothing of those of Hopkins, Forbes, Mallet, and other foreigners. The most successful of the Italian investigators in this respect would seem to have been Bertelli, who, with De Rossi, has paid attention to the study of the minute, almost microscopic movements of the pendulum which precede severe earthquakes, and which have been studied by the help of ninety-four accurate observations at as many different stations as they were reported to Serpieri. These were very equally distributed on all sides of the central disturbance, and show that the original shock was of the nature of a line of fracture extending from near Florence southeastward about fifty miles, within which region it seems possible that several fractures may have followed each other in rapid succession over neighboring portions of territory. A comparison of the observations made on the 12th of March, 1873, with those made on the 6th of December, 1874, and the 24th of February, 1875, as calculated by De Rossi in his analysis of the three great Italian earthquakes, show that in all these cases these transverse fractures in the terrestrial crust are succeeded by transverse vibrations in the same.—*Supplemento alla Meteorologia Italiana*, *Rome*, 1875, 56.

NOCTURNAL RADIATION.

Mr. Barham, in communicating to the Royal Institution of Cornwall some remarks on the surface temperature of the earth, states that the common estimate of the greatest cold during the night is derived from the record of a thermometer hanging up on a stand, or under a shed or other shelter; yet

the fact is patent to every one that, when the sky is clear, the temperature to which vegetables and man and animals out of doors are exposed is from 5° to 10° lower than that recorded by a sheltered thermometer; and it is just these additional degrees of cold, when the ordinary sheltered thermometer hardly sinks to the freezing-point, that destroy tender plants, and more or less seriously injure others. The difference between the temperature of a sheltered thermometer and that indicated by one partly exposed to radiation toward the sky depends, as is well known, on the cloudiness of the sky; and, if the sky be clear, on the quantity of invisible moisture in the air. A series of observations made for ten years at Helston, by Mr. Moyle, shows that in each year differences of 6° to 12° have been observed, the exposed thermometer being invariably the lower. At Pengerrick, near Falmouth, the difference between the minimum thermometer lying out on the grass and the minimum sheltered in an ordinary thermometer-screen sometimes amounts to 15° or 17°. The thermometers exposed to radiation, and lying not upon grass, but upon other substances, such as garden-mould, snow, sand, stone, and gravel, generally show slightly higher temperatures than those on grass. Their variations among themselves are, however, due to a somewhat complicated relation between the conduction of heat from the interior strata of the earth and the radiative power of the surface stratum itself. The radiative power of straw, whether flax, wheat, or rye, is one of the largest known. A bedding of straw is used, as is well known, in India in the process of forming ice during clear nights. From a series of observations made for a period of eighteen months on garden-loam, sand, clay, and peat, Mr. Whitley found that garden-loam showed a power of receiving and retaining heat superior to that of any other naked soil. The temperature of the peat was nearly equal to the garden-loam, although naturally wet and cold. Silicious sand did not come up to the expectations formed of it. Clay maintained a bad pre-eminence for coldness, but improved by good drainage in the second year's observations. The effect of a thin screen in preventing the radiation of heat at night was shown by some observations which prove that a screen of muslin does not protect the thermometer placed beneath it so well as straw matting. The matting is surpassed in its

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turn by a trellis-work, such as is ordinarily employed in summer-houses. A slight covering of straw is even more effective than such trellis-work. In general, in the climate of Cornwall, it may be stated that in sharp, dry, clear weather the soil that is covered with vegetation will be from 8° to 10° warmer if it is secured from the sky by straw matting, or other moderately thick material, spread horizontally at the height of three or four feet from the ground. Another element of greater moment in relation to temperature is the movement of the air. The blight caused by a local draught of icy wind may be frequently traced in well-defined lines in a gap in a northeastern hedge along the rows of early plants. A high wind will rob any horizontal screen of its protecting influence, but the placing of wattled hurdles or other effective vertical screens, about four feet high, on the windward side of a tender crop, in rows twenty or thirty feet apart, must be recommended as a preservative measure, even more important than a provision of horizontal screens. An umbrella carried by a person at night serves at times for protection against some 10° of cold, quite as efficiently as it at other times protects against the snow and the rain.—*Journal Royal Institution of Cornwall*, 1874, 111.

THE INTERNAL HEAT OF THE EARTH.

According to *Nature*, Professor Mohr, of Bonn, has made a very important contribution to our knowledge of the causes of the internal heat of the earth. He starts with the proposition that if the interior is still fused, then, as we approach this furnace, with every increasing depth a less space must be necessary to produce the same increase of heat. In other words, the increase of heat per hundred feet must become greater and greater in proportion as we descend. This, however, is directly opposite to the results of the most careful thermometric measurements, which show that at a depth of five or six thousand feet we come to a region in which the temperature ceases to increase; and even supposing large errors in these measurements, we must conclude that the region of constant temperature will be reached before we descend to a depth of fifteen thousand feet. Professor Mohr finds, from all the facts available to him, evidence that the cause of the increase of heat in the interior of the earth

must lie in the upper strata of the earth's crust; and the fluidity of the lava ejected from volcanoes is not a remnant of the ancient incandescence of the earth, but is due to a local evolution of heat caused by those shrinkings which have always been produced by the sea and its action upon solid rocks. The internal nucleus of the earth can lose but little heat outward by reason of the bad conductivity of rock, while, on the other hand, in the lapse of ages it must receive and propagate uniformly all the heat due to the shrinkages; thus a constant elevated temperature must prevail in the interior, and therefore that increase of heat which is met with every where in the earth is the result of all preceding heat actions uniformly distributed by conduction in the internal nucleus of the earth.—12 *A*, XII., 546.

ON THE RELATIONS BETWEEN TERRESTRIAL MAGNETISM AND THE AURORA.

It has been suggested by Lemström that terrestrial magnetism proper, although it may exercise a direct action upon those discharges of atmospheric electricity which constitute the aurora, yet can not contribute to the production of the aurora, since that must depend upon certain conditions of the different strata of air. The apex of the auroral bow is rarely in the direction of the declination of the needle, and the variations are too great to be explained as accidental perturbations in the earth's magnetism. The formation of the auroral corona is generally supposed to be an effect of perspective; but if it were due to this alone, the auroral rays should appear to unite at a very sharp angle, which is by no means the case; and Lemström is inclined to believe that one influence of terrestrial magnetism is to bend the auroral beams. In reference to this point, Professor De la Rive states that although the formation of the auroral corona depends upon the directing influence of the magnet upon the electric currents which form the auroral beams, and is not a simple effect of perspective, it must also depend upon the direction of the passage of the electric discharges through the atmosphere; a direction which itself changes with a conductibility, more or less variable, of the different atmospheric strata. Thus the united effect of perspective and flexure ought to give to the rays a curvature and a position which

can not always be the same. In short, the electric discharges which take place in the polar regions between the positive electricity of the atmosphere and the negative electricity of the terrestrial globe are the essential and only causes of the formation of the aurora, whose existence is, indeed, independent of that of terrestrial magnetism, since the latter only imparts to it a certain direction, and in some cases a movement. During auroras the most numerous and the most intense currents of terrestrial magnetism flow from the north to the south; but occasionally they are observed flowing from the south to the north. These latter, according to Lemström, are currents of induction; an opinion in which De la Rive agrees.—*Report of Sec. of Smithsonian Institution for* 1874, 234.

ON THE POWER OF LEAVES TO ABSORB AND RADIATE HEAT.

The power of leaves to radiate heat has been investigated by Maquenne, who has for this purpose employed the Leslie cube, one of whose faces was blackened and the other covered with the leaves to be studied. The temperature of the water in the cube did not exceed 40° Centigrade, so that the mechanical structure of the leaves was unaltered. Of eight plants whose leaves were examined, the radiative powers averaged from ninety-one to ninety-seven, that of the blackened face of the cube being one hundred. And it may be assumed that the radiative power is on the average ninety-five for all of these leaves, and possibly for most others. On the other hand, the absorptive powers of the leaves were observed by covering one of the two faces of a thermopile with lampblack, the other with the leaf in question, and exposing these successively to a warm piece of blackened wood. The absorptive powers of these leaves varied, as before, from ninety-four to ninety-seven, the average being ninety-five; and it was concluded that for obscure heat, (1) the emissive and absorptive powers were sensibly equal; (2) they are nearly equal to that of lampblack; and, finally, the determination of the quantity of dew which is deposited upon plants ought to be made by means of blackened pluviometers, or with gauges covered with some substance having a very considerable radiative power. If this were done, we probably should be able to explain the discrepancy which exists when we com-

pare the quantity of water evaporated by the cultivated soil with that which has been furnished to it by the rain. This excess could, in fact, only be accounted for in great part by the dew which covers the plants every clear night.—6 *B*, LXXX., 1357.

ON THE TEMPERATURE OF THE SOIL.

The Messrs. Becquerel have recently made a report to the Paris Academy of Sciences on the results of observations made in 1874 by means of a thermo-electric apparatus on the temperature of the soil at various depths, from forty meters up to the surface. The observations have been made many times a day, but only those made at six and nine A.M., and three P.M., come now into consideration. From a depth of one hundred and ten feet up to a depth of eighty-five feet the temperature was sensibly constant throughout the year. Even at fifty feet the variations were barely perceptible, although at this depth the effect of the penetration of surface water into the soil is ordinarily quite sensible. The effect of a covering of grass, as compared with that of a barren soil, becomes quite perceptible at the depth of twenty inches, where it is found that the covered soil experiences much less violent changes of temperature than a sandy or barren soil; so that even from six o'clock in the morning to three o'clock in the afternoon the protected soil is warmer than the barren soil.

In thé interest of terrestrial physics, it is to be hoped that we shall be able to establish at still greater depths a similar Becquerel apparatus, in order to discover at what point the temperature of the solid earth experiences, or ceases to experience, any changes in a long interval of time, whether in consequence of slow cooling, of earthquakes, or of internal changes.—6 *B*, LXXX., 773.

INFLUENCE OF FORESTS ON WATER-FLOW AND ATMOSPHERIC MOISTURE.

In order to contribute something to the controversy with regard to the influence of forests upon atmospheric moisture, Fautrat states that he has conducted certain observations in the royal forests of Hallette. He first measured the quantity of rain both above and below the foliage of the trees,

and endeavored to take account of the evaporation. He finds that soil covered with forests receives six tenths of the whole quantity of rain that falls, the foliage of the trees having intercepted four tenths. The hygrometric observations show that there is always in the neighborhood of the forests a greater quantity of atmospheric vapor than in the neighborhood of cleared lands; and this envelope of moisture is beneficial to the neighboring cultivated lands, as it flows out upon them during the night-time when such lands are cooled by nocturnal radiation, and the moisture is precipitated upon them as dew.—6 *B*, LXXX., 206.

CHANGES IN THE EARTH'S AXIS OF ROTATION.

The excellent investigation of Dr. Nyrèn upon the latitude of Poulkova and its apparent variability was briefly noticed by us at the time of its appearance; but the essay itself having recently come to hand, we will not forbear to mention that he has therein quoted numerous examples of the results found by many astronomers, all tending to show changes, and, in general, diminutions in the latitudes of the observatories of Europe. The special results for Poulkova, as deduced from the observations of Peters, Gyldèn, Nyrèn, and W. Struve, would lead us to conclude that there is even some probability that the variability of the latitude of this observatory may be an apparent one only, and be due rather to some slight error in the adopted value of the precession and nutation. The definitive determination of this point can probably only be reached by observations conducted uniformly at all seasons of the year through a number of years.—*Nyrèn, Die Polhöhe von Pulkowa.*

METEOROLOGY IN GERMANY.

The German Seewarte, at Hamburg, now under the general direction of the Imperial Hydrographic Office, has in a recent circular announced the further extension of its work. The first article relating to its organization being now in course of execution, in accordance with which it has proceeded to develop the system of observations and reports for ocean vessels, and has also established complete collections of charts and works relating to navigation, whose use is free to all vessels in the various German ports, the office has now

proceeded to carry out the third section of its work, viz., the collection of weather reports from stations in the interior of the continent of Europe and the issue of storm warnings. The object of the Seewarte is to study meteorology on a grand scale by means of simultaneous observations, and to thereby investigate the movements of the atmosphere as a whole instead of merely studying climatology. There will therefore be established seven first-class observing stations on the German coasts, with self-recording barometers and anemometers. At these observations are made at 8 A.M., 12 M., 4 and 8 P.M., two of which are telegraphed daily to Hamburg. A large number of minor coast stations are also occupied, and two completely equipped stations are supported by the Navy Department. In the interior of the German kingdom there are to be sixteen stations, which will, it is hoped, be supplied by volunteers from among the numerous amateur and professional meteorologists of Germany. The hours of telegraphic observation will be 7 A.M., local time, from April 1st to September 30th, and 8 A.M. from October 1st to March 31st. It seems that the telegraph offices are generally opened at 8 A.M., and this arrangement of hours has long been used by France, Sweden, and Norway. On the other hand, in England, Holland, and Denmark 8 A.M. is adopted uniformly throughout the year, while 7 A.M. is uniformly adopted by Austria and Russia.—*Circulars of July 5 and September* 20 *of Hamburg Seewarte.*

METEOROLOGY OF THE SIEBEN-GEBIRGE.

The greater part of the little pamphlet of communications published by the Sieben-Gebirge Natural History Society is taken up with an account of the meteorology of that portion of Germany. Seven stations are occupied in the neighborhood of these mountains; their altitudes vary from 200 to 700 meters. It appears from these records that throughout the year 1873 unusual warmth and dryness were experienced. The annual means of temperature at all the stations exceeded the normal means by very considerable quantities, while the annual total rainfall was every where less than the normal fall. Vegetation was remarkably forward in the springtime, and uninjured by unfavorable weather through the summer.—*Verhandl. Sieben-Gebirge Verein*, 1875.

METEOROLOGY OF CANADA.

In a recent volume of "Magnetic and Meteorological Observations from 1841 to 1871," Professor Kingston gives first the magnetic results of observations made at Toronto, which may be divided into three principal groups, viz., embracing the years 1840 to 1848, 1853 to 1862, and 1863 to 1871. For the latter group tables of the daily observations are given, while for the former group only summaries, condensed from the full publication of General Sabine, are given. The second portion of the volume is taken up with meteorological observations, and may be divided into two sections, the second of which contains tables of daily means for the period from 1863 to 1871, and the first section more general tables for the earlier periods, together with general formulæ representing the results of the discussion of the entire thirty years of observations. These discussions have been entered into with somewhat unusual minuteness, giving us the most thorough discussion of the climatology that we possess for any point in America, and more complete than most of the similar discussions to which European observations have been subjected.

THE METEOROLOGY OF MOUNT WASHINGTON.

Dr. Hellman has contributed to our knowledge of the meteorology of the upper regions of the atmosphere by a careful discussion of the observations made by the Army Signal-office on the summit and at the foot of Mount Washington in 1872. He finds that, as in Switzerland, the extreme maximum temperatures are attained later in the day, and the minimum earlier, at the summit than at the foot of the mountain. The mean daily range of temperature at the summit is 2.5° Centigrade, at the lower station 6.5°. The average decrease of temperature for the month of May is 0.07° for every one hundred meters of ascent, a result that agrees closely with that found by Hann to prevail on the average throughout Central Europe. The diminution of temperature with ascent varies, of course, with the direction of the wind. It is most rapid with the northwest, and least rapid with the southeast winds, and is evidently much more truly a local than a general physical law, as has indeed already been

shown by Hann, Mohn, and others. In general, the difference of temperature between the upper and lower stations is greater in clear than in cloudy weather.—*Zeitschrift für Meteorologie, Vienna*, X., 296.

METEOROLOGY IN THE 17TH CENTURY.

Caspari gives, in the *Revue Maritime et Coloniale*, an interesting review of a work published at the Hague by Vlacq in 1663. The work in question is by Vossius, "De Motu Marium et Ventorum." In this book the theory of the tides takes an important place, and after it the winds are treated upon in a manner showing the state of physics and chemistry in that century. The fable of the four elements is rejected by Vossius; the air is considered by him as being simply rarefied water, the principal source of which is found in the ocean. In reference to atmospheric theorems, the author indicates that observation has shown to him a remarkable correlation between the movements of the barometer and the gusts of wind. "For," says Vossius, "if the barometer is low and tends to rise, the danger is past. It is when it is very high that we know, on seeing it fall, that the tempest is coming. The amplitude of the movements of the mercury is in proportion to the violence of the wind." Our author, therefore, at so early a date as this, proposed to employ the barometer on board of a vessel for the prediction of the weather. In 1660, Otto von Guericke had remarked that a considerable barometrical depression corresponded generally with an atmospheric disturbance; but the inventor of the air-pump did not thoroughly understand the theory of the movements of this instrument; and we are forced to believe that practically Isaac Vossius should have the credit of first formulating this useful law, viz., that it is the direction of the movements at any instant, and not the simple readings of the height of the barometer, which should guide us in our predictions of the weather.—*Revue Maritime et Coloniale*, 1875, 330.

THE RESISTANCE OF THE AIR TO THE MOVEMENTS OF PROJECTILES.

An important subject in artillery practice is the resistance of the air to the movement of the projectile—a question that

is also equally of interest in the study of the movements of aerolites. M. Helie has concluded, from experiments made by him, that this resistance can be explained by the very simple formula, $r=a\times v\div b$; where v is the velocity of the projectile, and a and b are constants that vary with the difference of the projectiles. This formula holds good only between velocities of from 1000 to 1500 feet per second. The values of these constants have been determined by Helie for four different kinds of projectiles; and for great range of velocities the agreement between the measured and the computed velocities is remarkably close.—*Revue Maritime et Coloniale*, 1875, 333.

INDICATIONS OF SPRING.

Mr. Southwell recently read before the Norfolk and Norwich Naturalists' Society of England a review of the circumstances attending the publication of Mr. Marsham's "Indications of Spring." It seems that this work, which was published in the last century, was based upon observations which were begun to be made in 1736 by Robert Marsham at Stratton, Strawliss Hall, near Norwich. These observations were continued by Mr. Marsham throughout his life. The results of the first fifty years of observations were communicated by him in 1789 to the Royal Society. Mr. Marsham died in 1797; but his series of observations were continued by his son Robert down to the year 1815. In 1836 the record was taken up by the third Robert, and has continued without interruption until the present time. This series of observations, extending over nearly one hundred and fifty years, relate principally to the phenomena that would naturally be noticed by an observant naturalist; and the manuscript is replete with the most interesting particulars as to the progress of tree planting and growth, treatment of trees, periodic measurement thereof, etc. The earliest appearances of the birds common to that section of the country are quite regularly mentioned. Each year begins with a review of the order month by month, compiled from notes, and a daily register of the natural-history phenomena, interspersed with many valuable observations, and a table of the prevailing winds. It is often said in England that our old-fashioned winters have departed, and that the springs

have become later. The "Indications," as they extend over such a long period, and have been kept so nearly in the same spot, offer a good opportunity of testing if such be the case. To this end Mr. Southwell states that he has taken the average days of the occurrence of twenty-five different phenomena, which were fully observed during the ten years 1764 to 1774. He then did the same with the ten years 1864 to 1874. The result showed that the springs are now nine days earlier than they were a hundred years ago; nor does it seem probable that this difference is due to any fault in observing, though it possibly may be partly due to improved drainage and cultivation.—*Transactions Norfolk and Norwich Naturalists' Society*, II., 31.

ON BAROMETRIC PRESSURE IN EUROPE.

The great work of Buchan on the distribution of barometric pressure throughout the globe, and the recent work of Rikatcheff, which is especially confined to the distribution of atmospheric pressure in Europe and Siberia, are now supplemented by a memoir by Buys Ballot, who publishes, in the second part of his *Jaarboek* for 1870, a second edition of his memoir on the annual variation of pressure in Europe. The first edition of this work, which appeared in 1860, afforded the foundation by means of which meteorologists for many years have been able to ascertain when the pressure existing at a given place on any day was above or below its normal value. His present memoir is of much greater extent, and gives, of course, the results of many additional years of observations. It gives the monthly, annual, and decennial barometric means for one hundred and sixteen stations.—*Zeitschrift für Meteorologie, Vienna*, X., 324.

A REMARKABLE SHOWER OF DUST.

On the 30th of March last Mr. Nordenskjöld telegraphed from Stockholm that a vitreous fibrous gray powder fell with snow there during the night; and again, on the same night, in Norway, Dr. Kars observed the same phenomenon over an extensive region. The powder that fell on this occasion having been submitted to Daubrée for examination, he states that, by means of the microscope, he recognizes it as composed of fragments of pumice-stone; but, on chemical

analysis, other substances could be found in sensible amount. He concludes that the powder is undoubtedly of volcanic origin; and its great resemblance to the powdered pumice-stone found in Iceland points to that island as its origin. In the course of his remarks, alluding to other showers of powder, Daubrée quotes as an instance the ashes from the burning of the city of Chicago, which fell on the Azores the fourth day after the commencement of that catastrophe; which we allude to here in order that we may state that for weeks before and after the great fire in Chicago in 1872 great areas of forest and prairie land, both in the United States and in the British possessions, were on fire; the smoke and the ashes from which fires were inextricably commingled in the atmosphere with the smoke of Chicago; and we should deem it in the highest degree improper to say that the ashes of Chicago were landed in the Azores.—6 *B*, LXXX., 994.

FAYE'S THEORY OF STORMS.

The *Annuaire* for 1875, of the Bureau of Longitudes, Paris, contains a memoir by Faye, entitled a defense of the law of storms, in which he seems to advance certain theories of his own in order to defend views long since enunciated by Redfield, Piddington, and Reid. The novel views introduced by Faye, and suggested to him first, as he says, by his studies upon the solar phenomena, have been met by some criticisms of Peslin, who states that "the vorticose movement of the air in severe storms, which is needed in the new theory as well as in others that have been broached at different times, allows of a better representation of the direction of the winds at the surface of the earth than is furnished by the circular theories." The constancy with which all storms upon each hemisphere circulate in the same direction is due to the rotation of the earth, according to all other theories, while Faye advances the remarkable explanation that "it results from this, viz., that in strongly curved currents the velocity steadily diminishes as we pass transversely from the concave to the convex side of the current." In regard to the formation of rain in connection with extensive storms, Faye says that "in the air the temperature diminishes decidedly as we ascend. Now the moisture of the air is susceptible of condensation oftentimes by a very moderate

diminution of temperature. When, then, the cold air of the upper regions is carried down little by little in its whirling movement into the lower and moister strata, it causes all about it the formation of slight fog. This latter, like an exterior envelope or veil, renders visible thereby the contour of the mass of cold air. Doubtless the air in its descent, being subjected to compression, is warmed up somewhat, but it must remain always colder than the surrounding air, and the envelope of fog will be produced as long as its temperature remains below the dew-point of the general mass of air." To this view Peslin objects that, "according to the general mechanical theory of heat, the increasing pressure to which the mass of air is subjected as it is brought lower and lower into the atmosphere, ought to cause it to be, at any moment, warmer than the surrounding air, and that it ought, therefore, to be always impossible for such descending cold air to condense the vapor of the atmosphere with which it comes in contact." Faye states that the views of Peslin in this latter regard are not new to him, having been explicitly elaborated by Espy, and by the Commission of the French Academy that in 1841 made a formal report on Espy's theories; and he had fully considered this objection before he wrote his recent memoir, which has attracted so much attention, and that the truth of his own view will appear if, instead of confining ourselves to theory only, we combine therewith the observation of what actually takes place in nature.—6 *B*, LXXX., 658.

ON THE AMMONIA IN THE ATMOSPHERE.

Schlösing, in a memoir on the presence of ammonia in the atmosphere, states that the origin of this substance is to be looked for in the action of atmospheric electricity on the nitrogen and in the emanations from the soil, although it is doubtful whether the latter can be a very efficient cause. The direct assimilation of gaseous nitrogen by plants, and the emission of ammonia, is no longer admissible. The entire process is a sort of circulation. Nitric acid is produced by the electrical reactions in the atmosphere, and arrives sooner or later in the ocean. There, after having passed into combination with sea-water and its salts, it is converted into ammonia, and now the nitrogen compound is in a form fit for diffusion.

It passes into the atmosphere, and, moving with it, comes like carbonic-acid gas into the neighborhood of plants deprived of locomotion, to whose nutrition it contributes. There it is fixed in its travels, falls to the ground in decayed vegetable matters, forms arable land, and renders the soil fertile. The ocean, therefore, is to be considered as the main reservoir of nitrogenous compounds, and is, through the currents of the atmosphere, the regulator of the annual distribution of nitrogen over the continents.—6 *B*, LXXX., 175.

FAYE'S THEORY OF STORMS.

In his debate with M. Peslin, Faye has stated some of the features of his views in regard to atmospheric storms as follows: First, cyclones, hurricanes, typhoons, tornadoes, and waterspouts are phenomena of one and the same mechanical nature, and to all of which the same general explanatory theory will apply. Second, since the eye can embrace the two latter phenomena in their totality, while the other three classes of storms are spread over too vast an extent of territory for any one observer to seize all their features directly, therefore we ought at first to begin our discussion and investigation with the consideration of tornadoes and waterspouts, at least if we desire to base our conclusions upon facts only. Third, the greater part of meteorologists attribute these phenomena to a vertical aspiration, whose existence they gratuitously assume at the commencement of their investigation. Under certain statical conditions of the atmosphere this aspiration can, according to them, develop mechanical effects of astonishing power. According to them the gyration which is so characteristic of these storms is only an incidental matter, resulting simply from the reaction of the ground upon the horizontal currents, that ground being animated by its slow daily rotation. This reaction, which changes by only 40° the direction of the lower trade-winds in their long course, is made to describe many circumferences in the space of a few yards and in the interval of a few seconds, in the course of these pretended horizontal currents, whose existence not a single observer has as yet noticed. According to the theorists, these latter converge violently from all sides toward the lower orifice of the waterspout or the tornado, in order then to spring vertically through this

narrow orifice up to the region of the clouds under the form of a column, surrounded by vapors condensed by cooling, and spreading as they ascend. Fourth, on the contrary, I submit that the common origin of all these phenomena is found in the upper currents, whose power and directions are clearly shown to our eyes by the clouds, and not in the lower strata, where an almost perfect calm continually reigns. Not, of course, that a calm reigns at the precise spot where the waterspout exists at any moment, but all about it. Upon this capital point, so easy to demonstrate, so frequently denied by observers, and which lends so much to the solution, all the witnesses are agreed. This does not prevent the aspiration theorists from placing violent currents, like immovable layers, around the heart of this perfect calm, which the waterspout or the tornado does not disturb for an instant in its rapid course. Never have we seen in science a similar disregard of facts; a strange indifference which is explained only by the influence of a very ancient and very extended prejudice, whose history I have traced in the *Annuaire* for 1875, and which has caused meteorologists to replace facts by theories upon the stability or instability of atmospheric equilibrium.—6 *B*, LXXX., 660.

THE EFFECT OF MOVEMENT OF THE AIR ON THE BAROMETER.

M. Faye having stated in his defense of the law of storms that the barometer does not measure the weight of the atmosphere above us, but that its indications are to be interpreted by dynamical and not statical principles, this idea has been made by Montigny the subject of a communication to the Belgian Academy, on the different pressures exerted by the air upon the barometer, according as it is in movement or quiet, and upon the estimation by means of the barometer of altitudes in balloon ascensions. Montigny has communicated some five or six memoirs on the relation between the height of the barometer and the pressure of the wind. Among them is a series of interesting determinations of the height of a point in the cathedral of Anvers, by means of barometric observations taken under very varied influences as regards the direction and velocity of the wind. These observations had especially as their object to show that the law of diminution of pressure is not the same when

the air is in movement as when it is at rest. Barometric measures made in the tower of the cathedral at Anvers when the air was calm gave results sensibly accordant with the true height as measured by the level. On the other hand, measurements made when the west wind prevailed gave results too high, and those made when the east wind prevailed gave results too low, the difference being fourteen feet. It does not appear, however, that Montigny has taken account of the relative directions between the wind and the opening of the windows and doors of the room in which he was placed—a point which, as is well known from recent investigations, is of the highest importance if so great accuracy would be attained. —*Bull. Acad. de Belgique, Bruxelles*, 1875, 820.

ON THE ACCURACY OF THE ANEROID BAROMETER.

The increasing accuracy of the aneroid barometers as manufactured by the best makers, and the numerous applications of this instrument to the determination of altitudes, have led to several excellent investigations into the errors and reliability of the instrument, among which one of the best is due to G. Grassi, recently published in the supplement to the *Meteorologia Italiana*. The first instrument examined by him was made by Casella, of London, which was compared with an excellent siphon-barometer. Subsequently a number of others, some of them made by different makers, were obtained, and subjected to the same course of investigation. Grassi summarized his results as follows: First, aneroids that are subject to great variations of pressure need corrections which have a regular progression, and are generally of very similar form. Second, each aneroid must have its own proper corrections. Third, there exist pressures for which the corrections are nearly constant. Fourth, there exist other pressures at which the corrections experience sudden changes, sometimes an increase, sometimes a decrease. Fifth, if the corrections are plotted as curves, the ascending or descending portions of these will be sensibly parallel. Sixth, sudden jumps are in a positive direction if the preceding period is one of increasing correction, and *vice versa;* the jumps are negative if the preceding period is one of diminishing correction. Seventh, the magnitude of a sudden jump is pro-

portional to the extent of the period that precedes it.—*Supplemento alla Meteorologia Italia, Rome*, 1875, 28.

THE SIMULTANEOUS EXISTENCE OF DIFFERENT CURRENTS OF AIR.

The exact knowledge of the presence of several currents of air in the atmosphere around us is of so great importance to meteorology that we record here the observations made by Chapelas in France. On the 30th of April, at noon, he observed a clear sky with a feeble northeast wind. At two o'clock P.M. a slight thread of cirrus was seen moving rapidly from the west-southwest or southwest, the surface wind remaining still northeast. On the first of May both wind and clouds moved from the southwest at ten o'clock A.M.; and at one thirty P.M. a strong storm, followed at night by clouds and wind from the northwest. On the second of May at seven P.M. there appeared a balloon driven by a wind from the west-northwest to the northeast, while at the surface of the earth it was quite calm. The balloon descending in the Luxembourg quickly, when it arrived at an altitude of about one hundred and fifty feet met a current diametrically opposed to that which it had experienced above, and was carried by it toward the southeast.—6 *B*, LXXX., 1176.

ON THE LAWS OF CYCLONES.

The distinguished astronomer, Faye, of Paris, having been led from his study of solar spots to investigate the subject of terrestrial storms, has developed numerous novel views, which will be found fully noticed elsewhere, and has lately applied these views to the study of the hurricane of February 25, 1860, in the Indian Ocean. In this hurricane some forty vessels were destroyed, and their loss is attributed by him in great part to implicit confidence of the navigators in the laws for avoiding the centres of hurricanes that have hitherto been promulgated. It is well known that Mr. Meldrum, by studying this same storm, was led to certain modifications of the ordinary hurricane laws, but Faye differs widely from his conclusions. Similarly Captain Ansart proposed to reject the circular theory of cyclones, and to substitute ellipses for the spirals of Mr. Meldrum. By referring to the original observations, so far as they are available for

the study of this storm, Faye concludes that it is necessary to take account of the trade-winds in enunciating the laws of those storms which occur in the regions of those winds; and he proposes the following practical conclusions which he would submit to navigators:

"In order to determine the position of the centre of a cyclone in the region of the trade-winds, if the observer finds himself within its borders in the semicircle exposed to the winds, he ought to apply the ordinary rules, not to the wind that he experiences, but to that wind which, conjoined with the known trade-wind of that region, would give as its resultant the wind actually observed by him, both in direction and force. If we obtain graphically two distinct determinations of the centre, we can, if there is occasion to do so, correct this first approximation by introducing therein the velocity of translation of the centre of the cyclone or of the vessel."—6 *B*, LXXXI., 64.

DISTRIBUTION OF ATMOSPHERIC PRESSURE.

One of the most important meteorological publications of the year consists in that by Rikatcheff on the distribution of atmospheric pressure in European Russia. Having access to all the original documents, and having himself visited many Russian stations in order to secure perfect accuracy of instruments, Rikatcheff has been in a favorable position to give us the very valuable memoir which he has succeeded in compiling. The results of his work are given in the shape of a series of tables and charts, showing the distribution of pressure throughout Russia and the neighboring countries. In concluding his work, he says that there are still wanting the necessary data in order to use some half-dozen stations for which observations are at hand. But, apart from these, the charts of isobars which he gives represent very approximately the distribution of pressure for each month and for the whole year. According to these, by simple interpolation, the mean height of the barometer for any given point of Eastern Russia can be obtained with an accuracy of about one millimeter; and for Western Russia with an accuracy of one fifth of a millimeter. There is no successful attempt at an explanation of the low barometer in Northern Europe, and the author appears to be quite in ignorance of the theoretical

works of Ferrel on this subject.—*Vienna Zeitschrift für Meteorologie*, 1875, 290.

THE EUROPEAN DROUGHT OF 1875.

The period of great drought, which lasted from February to April, 1875, in Europe, has been treated of by M. Lancaster, aid at the Royal Observatory of Brussels, who states that this period merits our attention. The rainfall during these three months has never, since 1833, been so small as during this year. The mean of the forty-two years of observations at Brussels gives for the three months 144 millimeters, while the height for 1875 is only 46 millimeters, or less than one third of the normal height. The pressure of the air has generally been high. The temperature has been subject to considerable variations, having been on the whole slightly below the average. The wind has presented the most interesting phenomena; the predominance of northern currents during March and April is especially remarkable. The drought extended even to the middle of June, although by that time a little water had fallen.—*Bullet. Acad. Roy. de Belgique*, 1875.

GLAISHER'S OBSERVATIONS OF MOISTURE IN THE ATMOSPHERE.

In the annual memoir at the opening of the Gymnasium at Sondershausen, the Director, Dr. Kieser, in an essay on the moisture in the atmosphere, states that he has carefully computed the extensive series of observations made by Glaisher in reference to the absolute and relative humidity at different altitudes. His results are presented in tables, showing the state of the atmosphere at every one hundred meters from the earth's surface up to a height of six thousand meters. He concludes, first, that it is demonstrated that the absolute humidity diminishes with the altitude, although exceptions are not uncommon; second, that therefore the surfaces imagined to be drawn through the atmosphere defining the regions of equal quantities of vapor have a wave shape, depending upon purely local circumstances; third, the quantity of vapor is different at the same altitude in different months; fourth, the density of the vapor diminishes much more quickly than the density of the air as we ascend. Thus the density at five thousand meters is about half of that at

the surface of the earth, while the quantity of moisture at that altitude is, during August, from a fourth to a fifth, in September an eighth, and in April less than a tenth of that observed at the surface of the earth; fifth, at altitudes of six or seven thousand meters the absolute humidity is very small throughout the year, and less than one grain of vapor is to be credited to every cubic meter of air; but at the greatest altitudes that have been reached there has been found no perfectly dry air. Thus the relative humidity increases as we ascend from the earth's surface until we reach the level of complete saturation, but above the clouds the diminution of relative humidity diminishes suddenly. The ordinary condition of the atmosphere appears to be that of successive layers of moist and dry air. — *Gymnasial Programme, Sondershausen*, 1874.

ON THE RAINFALL AND EVAPORATION IN INDIA.

In a memoir by A. R. Binnie on the Magpur water-works, he gives some details with reference to the rainfall and the drainage at Magpur. This city is situated in latitude 21° north, longitude 79° east, at an elevation of about 1000 feet above the sea-level. The average rainfall for the nineteen years from 1851 to 1873 was 40.7 inches, of which 37.5 inches fell during the monsoon months from June to the middle of October. Although the general fluctuation of rainfall in India is similar to that in other parts of the world, yet it has certain well-marked peculiarities, the first of which is that the greater part of the annual rainfall is confined to a few months during the southwest or southeast monsoons; second, the greater part of the year is almost rainless; and, third, during the wet months the rainfall is much more intense than in temperate countries. In the most violent showers that have been noticed in that place the rain fell at the rate of 4.7 inches per hour. To determine the quantity evaporated from the surface of the ground is a matter of difficulty; but Mr. Binnie attempted, by careful observation of the level of the water in the receiving-basin during the dry season, and by comparing the result with the existing meteorological circumstances, to estimate the amount. During that period in which no water ran into the basin, the quantity in the latter diminished, in 242 days, to the extent of seven feet

The diminution varied from 0.045 to 0.024 of a foot per day. The fluctuation of the rainfall year by year is quite large, and so distributed that on the average sixteen periods of great and little rainfall may be anticipated in every hundred years. Since it has been, during the past few years, suggested that the periods of fluctuation of the spots on the sun's disk bear a relation to the fluctuations of rainfall, similar to those which have been demonstrated in the case of terrestrial magnetism, Mr. Binnie has sought to test the truth of this statement by making a comparison between the fluctuations of the rainfall at fourteen places and the solar-spot periods from Schawbe's observations; but no satisfactory result or accurate deductions could be drawn from this test.—*Journal Institution Civil Engineers.*

ON THE THEORY OF HAIL.

Renou having proposed some objections to the theory of the formation of hail which Faye has recently had occasion to develop in connection with his theories relating to storms, he has replied to Renou, to the effect that hailstones are, in general, formed by successive accretions of coatings of ice, which latter are due to the cooling of the air to a point below its dew-point and below the freezing-point. Admitting that the nucleus may have a very low temperature, the same, viz., as that of cirrus clouds, it is easy to see that in virtue of this low temperature it will congeal around it a thin layer of transparent ice, and that, if the physical and mechanical conditions where it is remain the same, the hailstone will be kept at a temperature in the neighborhood of the freezing-point, and will, by the consolidation of the thin envelope and evolution of heat, no longer continue to grow, but need again to be cooled. The thickness of the shell thus formed after any one exposure to the moist air can not exceed one twelfth of the diameter of the nucleus.—6 *B*, LXXXI., 513.

RAINFALL OF BOHEMIA.

Among the recent monographs upon meteorological specialties, we notice a memoir by Professor Studnicke, read before the Bohemian Scientific Association of Prague, on the rainfall of Bohemia. The climatology of Bohemia has been most exhaustively investigated by Kreil in his work of that

title, published in 1865; but in the matter of rainfall Studnicke has had special opportunities which have enabled him, to say nothing of the lapse of the past ten years, to present the fullest particulars and material. Thirty-eight stations were indeed represented in the memoir of Sonklar on the hyetography of Austria; he was, however, unable, even with this number of stations, to properly represent the southeastern portion of Bohemia. The gaps that were necessarily found in Sonklar's and Kreil's works have been filled up by Studnicke, who was three years ago put in charge of the meteorological section of the committee for the scientific survey of Bohemia, and who has been instrumental in adding about fifty new stations to those already existing. Especial study was made in the neighborhood of Prague, where four new stations were established, in order to elucidate the differences in the records of the older observations.—*Sitzb. K. Böhm. Gesellschaft*, 1874, 62.

MOISTURE IN THE ATMOSPHERE.

Mariè Davy states that there is kept in active service in the meteorological observatory at Mont-souris a collection of apparatus for investigating, in a general way, certain physical problems of the atmosphere, especially the quantity of aqueous vapor contained therein. The apparatus consists principally of a large telescope, with silvered objective and a photometric ocular. This ocular consists of a Foucault polarizing prism, behind which is placed a double-refracting analyzer movable about the centre of a graduated circle. By the use of this apparatus we measure the ratio of the intensity of the light given from the sun, and from any part of the atmosphere in its immediate neighborhood; this ratio varies with the state of the sky. A similar operation would give the measure of the apparent intensity of the solar spots. A second telescope of smaller dimensions is mounted equatorially. Its objective is uncovered, and its ocular is similar to the preceding. A disk of white enamel is fixed horizontally on a pillar; at the side of the disk is found a smaller one of copper, which projects its shadow upon the enameled disk when illuminated by the sun. This shaded circle is then only lighted by the diffused light of the sky, while the neighboring parts receive also the direct rays of the sun. The

telescope previously described, or the photometer, gives then the ratio of the intensity of the two lights. Some white disks with black centres placed at various distances give with precision the degree of transparency of the air in day-time. The transparency of the sky during the night can also be found by the same instrument; but the results differ according as the moon is or is not above the horizon. The thermo-electric actinometer of Dessaine has also been modified in its applications by Mariè Davy. The cyanometer of Arago is also made use of.—*Bulletin Mensuel Observatoire de Mont Souris*, 1875, 129.

THE OBSERVATION OF POLAR BANDS.

The *Wochenschrift*, published for so many years by Dr. Heis, of Münster, has lately been transferred to the editorship of Dr. Herman J. Klein, of Cologne, well known to lovers of astronomy by his numerous popular essays. In his hands its interest will not fail of being maintained. Two recent articles by him are especially worthy of notice, one on the importance of observations of that form of clouds ordinarily known as polar bands, which have acquired a new interest owing to the observations and theories of Prestel and Hildebrandsson. In another article Dr. Klein calls attention to the project long since made by Dr. Falb of using the asteroids as a medium for determining the brightness of the faintest fixed stars.—*Klein's Wochenschrift*, 1875.

TIME OF SETTING SELF-REGISTERING INSTRUMENTS.

In the report of the meteorological section of the Leicester Literary and Philosophical Society, we learn that the time of setting the self-registering instruments has been altered from 9 A.M. to 9 P.M. This alteration has been made in consequence of the recommendation of the Vienna Congress, which has been adopted by the official and by all the principal private observatories of England. A new and more complete graphic method has also been adopted for displaying the daily readings of the meteorological instruments. By this method a whole month's daily readings are now exhibited in tabular form on a single sheet.—*Leicester Literary and Philosophical Society's Report*, 1875.

ON THE WET AND DRY BULB THERMOMETER.

One of the most serious defects in the use of the August Psychrometer, or the wet and dry bulb thermometer, is due to the fact that the radiation from surrounding objects affects the covered thermometer quite differently from its effect upon the naked. In order to remedy this defect, Overbeck, of Batavia, proposes to place the instrument within a shelter formed of thin upright sheets of metal, so that the direct rays of the sun can not strike the instrument. Metal has some advantages over the wooden screens usually employed.—*Tijdschrift Voor Nederlandsch Indie, Batavia*, 1874, 120.

PERIODICITY OF THE AURORA.

Professor Fritz, whose great catalogue of all known auroras was published in 1873, has recently communicated to the Natural History Society of Zurich an investigation into the relative periodicity of auroras and solar spots. He finds the differences between the years of greatest auroral and sunspot frequency are sometimes positive and sometimes negative; but in general the maximum of the auroras occurs seven tenths of a year after the maximum of sun-spots, while the minimum of auroras occur three tenths of a year before the minimum of the sun-spots. These differences, however, are too uncertain to be spoken of as a definite law. As regards the greater period of 55 years, he concludes that for the present we can not improve upon the determination made by himself in 1865, when he showed that this periodicity could be best represented by assuming that it coincided with five of Wolf's 11-year periods, or 55.55 years. He considers it also probable that there is a still longer period of 222 years in auroras, which, of course, we are unable to detect in the solar spots for want of observations.—*Vienna Zeitschrift für Meteorologie*, X., 317.

THE NEW PHYSICAL OBSERVATORY NEAR ST. PETERSBURG.

Dr. Wild, of St. Petersburg, Director of the Physical Central Observatory, gives an account of the establishment near St. Petersburg, at the well-known summer resort Pavlosk, of an auxiliary observatory, at which it is hoped numerous in-

vestigations may be carried on which could not be brought to successful conclusion at the central office in St. Petersburg. This new physical observatory consists of a principal stone building, with a high tower for anemometric observations, and contains physical, chemical, and photometric observatories, workshops, etc. A magnetic apparatus of the most complete nature is established in a subterranean cellar room. Dwellings for the officials will also be erected. The entire cost will not be far from one hundred thousand dollars in gold. The erection of the new building will begin in the spring of 1876. The annual appropriation for the institution will amount to thirteen thousand dollars, while the similar appropriation for the central institution at St. Petersburg, which amounts to thirty-six thousand dollars, will not be diminished, in order that it may carry on to completion the great works already begun.—*Vienna Zeitschrift für Meteorologie*, X., 293.

THE HURRICANE OF SEPTEMBER 9TH TO 17TH, 1875.

The hurricane of September 9th to 17th is described in the *Monthly Weather Review* of the Army Signal-office as one of the most violent that has occurred since the establishment of the Weather Bureau. It was first observed in latitude 13° north, longitude 17° east from Washington, and appears to have originated to the east of Barbadoes. Passing thence toward the west-northwest, its path curved around, striking the coast of Texas, whence it moved toward the northeast until it disappeared in latitude 38° north, longitude 6° east. On the 14th the morning reports announced that the centre of the storm had already passed to the westward of Key West and Havana. Very perfect records of the changes in the barometer and winds have been preserved at the Galveston and Indianola stations, at which place it was at its height on the 16th and 17th. The lowest barometers were, at Galveston 29.04, and Indianola 28.90. The maximum velocity of the wind at Galveston was sixty miles per hour, from the southwest and west. The maximum at Indianola was eighty-eight miles per hour, from the northeast, as registered by the anemometer. This instrument having however been destroyed by the continued gale, it was estimated that the velocity subsequently attained one hundred miles per hour.

The extreme severity of the storm seems to have been felt on the coast of Texas. In its subsequent course it extended over a larger area, and seems to have produced heavy gales on the Jersey coast, and to have had some connection with the violent storms which prevailed on the North Atlantic Ocean to the north of Great Britain from the 26th to the 29th of September. The heavy rains that accompanied the storm during its prevalence over the Gulf of Mexico contributed to the large excess of precipitation which prevailed in the Gulf States for the month of September.—*Monthly Weather Review for September*, 1875.

THE DIRECTION OF CIRRUS CLOUDS.

The movement of the cirrus clouds has been the subject of study by Hildebrandsson, of Upsala, who hopes thereby to deduce some results relative to the ascending and descending movements of the atmosphere above the regions of high and low barometer. The observations of Clement Ley show that the cirrus clouds move from areas of minimum toward areas of maximum pressure, and Hildebrandsson has endeavored to extend this interesting generalization over a wider field. He states, in fact, that a general study of the clouds over the whole of Europe shows him that while the air on the earth's surface moves in spiral curves, inward, toward low barometer, the air at a high altitude simultaneously moves outward. The upper winds, therefore, constantly make an angle toward the right with the lower winds. This demonstration was in 1871 also made by Abbe for the United States, and may probably now be considered as a general rule, applicable throughout the world. It is important to notice that the same conclusion was arrived at deductively by Ferrel in 1857, and is fairly stated in his great work on the motions of bodies on the earth's surface.

THE TEMPERATURE OF THE EARTH.

The interest which attaches to careful observations of the temperature of the earth suggests that the apparatus which is used in Germany should be better known in this country, in order that, when practicable, it may be introduced here. The following is a description of it as used by observers in Hungary. In its general outlines it does not differ from that

recommended by Lamont. It consists principally of a rectangular tube buried permanently in the earth, within which five rectangular prisms of wood are placed, one above the other, at different depths in the ground, and which, by a simple arrangement, can be easily and quickly drawn up. Each of these tubes contains a thermometer, and there is a hole in the side of the main tube, opposite to the bulb of the thermometer, where the wood-work is cut away, and the opening closed by a plate of thin sheet copper, whose temperature may be presumed to be the same as that of the adjacent ground. The depths at which the thermometers' bulbs remain are 4, 8, 12, 16, and 20 feet. Schenzl, as the result of observations made during eight years, finds that the time required for heat to penetrate to a depth of one meter is, on the average, 21 days.

THE INTENSITY OF TWILIGHT.

Mr. Williams, a student of the Massachusetts Institute of Technology, has made some observations to determine the quantity of light reflected during the hours of twilight, when the sun is at different distances below the horizon. The photometer employed was a slight modification of the Bunsen photometer. The illuminated disk was exposed on one side to the light from a standard candle, and on the other side to the light admitted from the sky.—*Proceedings Am. Acad. Arts and Sciences*, 1875, 421.

ON THE QUANTITY OF LIGHT REFLECTED BY THE SKY IN THE DAYTIME.

The quantity of light reflected by the sky at any given distance from the sun has long been a subject of meteorological observation, the first rude attempt at its measurement being made by the use of Saussure's cyanometer. Some elaborate investigations have been pursued for a long time at the Mont-souris Observatory. An interesting investigation of the question by a simple photometric apparatus has recently been published by Crosby as a student under Professor Pickering of the Institute of Technology at Boston. His objects were to determine, first, the absolute amount of light received from the sky at different distances from the sun, and second, to ascertain the law of diminution of light with in-

creasing angular distance from the sun. The method pursued was to so adjust the apparatus that an image of the sun would fall upon the Bunsen disk of the photometer, and then to measure the intensity of the light at regular intervals of time, as the sun receded from the portion of the sky whence the light was received. Observations were made on days both hazy and clear; and notwithstanding the great differences in the intensity of the light, it was found that it was proportional to some power of the sun's angular distance. This power was approximately for hazy days=1.04, but for the clearest days = 1.21.—*Proceedings Am. Acad. Arts and Sciences*, 1875, 425.

WIND VELOCITY AND THE BAROMETRIC GRADIENT.

The term barometric gradient was introduced into meteorology some years ago by an English engineer to express the rate at which the barometric pressure varies as we pass from one part of the country to another. It has long been adopted by Europeans as a rule in weather forecasts, that rapid changes of the pressure or steep barometric gradients will be followed by strong winds blowing nearly at right angles to the direction of the gradient. The explanation of this well-established generalization was partially given some years ago by Professor Ferrel of the United States Coast Survey; and his views have been adopted of late years by most European meteorologists who have studied dynamic laws. According to Professor Ferrel, whenever, from any cause whatever, an influx of air takes place from the surrounding regions toward a central spot, a gyratory motion must at once be set up, as illustrated in the whirls at the corners of the streets and in the tornadoes and hurricanes of the tropics. A very slight disturbance in the equilibrium of the atmosphere, such as would scarcely be shown by any but an unusually exact barometer, suffices to initiate the inflow of air and to give rise to the gyrations. If the earth were not revolving upon its axis these gyrations would take place in either direction, viz., either with or contrary to the movements of the hands of a watch; but owing to the great power of the immense velocity with which the earth revolves on its axis daily, the direction of all gyratory movements in the northern hemisphere is regulated thereby, being in fact uni-

formly contrary to the movement of the hands of the watch. It is to the centrifugal force due to this gyratory movement, by reason of which the air may be considered as revolving not only about the centre of the hurricane, but also about the earth's polar axis, that Professor Ferrel attributes the greater part of the depression of the barometer which is observed at the centre of the storm. The amount of this depression can be quite exactly calculated by the formula given by him. Not only does the air revolve about, but it also preserves its tendency to move inward toward the centre of lowest pressure near which it rises, and then the upper region of the atmosphere continues its gyratory movement, but flows outward, gradually descending until it meets the earth again. Professor Ferrel has been successful in explaining satisfactorily, by one single formula, and in grouping together under one common point of view, the phenomena of tornadoes and waterspouts and extensive hurricanes. His formula, after allowing for the density of water, applies also to the movements of the ocean; and by means of it he is able to compute the gradient of sea-level due to the deflecting force of the earth's rotation, showing that, for instance, we obtain about six tenths of a foot as the depression in sea-level due to a change in position of a hundred miles on a parallel of 30°, the sea-level being highest in the middle of the gyration, that is to say, in the central portions of the Atlantic and Pacific Oceans.—4 *D*, *November*, 1874.

THE MECHANICAL THEORY OF CYCLONES.

Among the treatises on the mechanical theory of the movements of air in revolving storms, both hurricanes and tornadoes, but few have such practical value as that of Colding, published in Danish in 1871, translations of which have recently been prepared by Hann, of Vienna, and Abbe, of Washington, by means of which the English-reading public is introduced to a series of novel investigations into the flow of liquids, which forms a very acceptable addition to our knowledge of the subject. According to Colding, the laws governing the movement of water may, with certain restrictions, be applied to the movement of the air; and after having, as an engineer, for many years successfully studied the currents of rivers and oceans, Mr. Colding has applied his

results to the study of a few hurricanes. The mathematical formulæ by which he has endeavored to show the relation between the velocity and pressure of the air and the dimensions of the whirlwind are apparently deduced in a not very rigorous, but sufficiently approximate manner. On applying them to the actual observations taken in connection with the hurricane of 1837 (the so-called Antiguan hurricane), and also to the hurricane of the 21st of August, 1871, he finds that the formula represents the observations with a degree of accuracy probably within the errors to which the observations themselves are likely to be subject. The simple principle according to which he is able to calculate the nature of the final shape of the surface which is shown for instance whenever water is allowed to flow out of a bowl through a central hole, consists in this, viz., that when the rotation is once established in the water, each particle describes a circle about the central axis, whose radius is such that the pressure of the water above the moving particle exactly counterbalances the centrifugal force due to its circular rotation. In the case of the atmosphere we have, instead of a well-defined surface, a series of surfaces of equal pressure, and the centrifugal force due to the circular movement around the centre of the hurricane is counterbalanced by the pressure of the atmosphere at that point. Unfortunately, Mr. Colding seems not to have taken account of the force due to the rotation of the earth on its axis. His equations, therefore, apply to tornadoes and to the central portions of hurricanes better than they do to the exterior portions of large storms.—*Zeitsch. für Meteorologie, May*, 1875, 133.

THE MONSOON.

In the magnificent volume of magnetic observations at Trevandrum, in Southern India, Mr. Broun gives the following interesting account of the advent of the monsoon. He was stationed at certain times at an auxiliary observatory on the peak known to the natives as Agustia, whose altitude is over 6000 feet, and which from time immemorial had been superstitiously regarded by the Hindoos as the residence of Agustia, a savant, physician, philologist, and theologian, whose principles were celebrated for their purity. Mr. Broun states that during his visits to this peak he made

daily notes of the appearance of the clouds and sky, and that there is no place in India where the magnificent phenomena which precede the bursting of the monsoon can be seen and studied with more ease. The peak in question is one conspicuous for its height and its isolation. As seen from Trevandrum, it rises in the form of a sharp-pointed cone. On the west it is a precipitous wall for nearly two thousand feet, and on the east it descends at an angle of about 60° with the horizon. Standing on its summit, for a month or more before the final crash of the tempest, the whole operations of the great atmospheric laboratory are developed at one's feet, while the summit of the mountain itself is rarely visited by the storms which rage over its western flanks. On the occasion of his first ascent, Mr. Broun states that, arriving at the summit, he saw to the west Trevandrum lying on the low lands, the intermediate plains spotted with clouds, shadows, and bright sunshine. A thick stratum of clouds, about on his own level, was, however, coming rapidly toward him, and in five minutes after dashed like a hurricane on the cliff below, burying the summit in a dull, gray light and a wet mist. Within the next two days they had twelve inches of rain, and it was evident that the monsoon had set in. On a subsequent visit, made during the dry season, he had ample occasion to study the gradual approach of the monsoon, and in general states that in the mornings chains of finely formed cumuli seemed to rest over the eastern horizon of Malabar and Coromandel. These clouds were irregularly distributed over the country, their shadows projected vertically at noontime, spotting and checking the plains between the sea and the mountain. Early in the morning the vapors began to rise near the western precipices, the clouds accumulated and sought to escape by the lowest passes into the eastern valleys, but were opposed by a repulsive influence, although no breath of air was felt. At last, after noon, in mighty masses it ascended, crowned with cirrus cloud, which spread eastward like an immense parasol overhead. Then the lightning began to play from cloud to cloud, followed by thunder, and drenching rain in the forests below. After one or more hours, according to the distance from the monsoon, the clouds left the mountains, retreated westward, and then

disappeared, the sun shone out from the western sea, the stars sparkled in all their beauty, and the next morning again brought the chain of clouds on the horizon. As the time for the monsoon drew near the cloud-masses with more and more energy endeavored to pass the mountains eastward. Sometimes two such masses presented themselves, one creeping up the eastern valley and the other entering the valley from the west. Day by day the returning clouds made a little further progress. At length on the decisive day, driven on by a giant force, they rose to the tops of the mountains, and poured over their walls into the eastern hills like steam from a great caldron. They plunged first downward, and then curling upward disappeared in the hotter eastern air. The storm with deluges of rain swept across the mountain, and the monsoon reigned over the low lands of Malabar.—*Trevandrum Observations*, I., 517.

ORIGIN OF COLD WAVES OF AIR.

Dr. Klein, in reference to the use of daily weather reports, states that in Europe as in America, in all cases, the reports of the weather westward of a given station are of the greatest importance, while reports from stations to the east are, on the average, of minor importance in making weather predictions. A southerly wind in the region of Ireland, Scotland, or Norway indicates the approaching side of an area of low barometer. It is therefore a sign of a coming change in the weather. A northerly wind in those regions indicates, for Germany, that the pressure of the air from the ocean is high, and can be considered as a sign of steady pleasant weather. Irregular changes of atmospheric pressure and of the winds are extremely slight in Eastern Asia, and the cold of winter when once commenced continues uninterruptedly in Eastern Siberia with a permanent high barometer. The reason of this is found in the existence of the great mountain chains of Asia. The region of high barometer is generally separated from oceans and from equatorial regions by these lofty chains of mountains. The coldest and densest stratum of air can therefore not flow away toward the sea. Its only escape is found at points like Jakutsk, where it passes over land 3000 feet above the ocean. Thus, throughout the whole interior of Asia, the lower stratum of air remains quite cold and heavy,

until the summer sun, heating the surface of the earth, stirs up the atmosphere, very much as water boils in a vessel over the fire. That which takes place in Asia is repeated in a much less intense degree in America. The area of the greatest cold on this continent is not prevented by any range of mountains from extending southward and eastward, but is only hemmed in on the west by the Rocky Mountains. Thus while the Pacific coast is protected from an overflow of very cold air, the whole eastern portion of America becomes peculiarly subject to it.—7 *C*, II., 9.

DALTON'S LAW, AND THE CONSTITUTION OF THE ATMOSPHERE.

It is well known that the famous law of Dalton, with reference to the diffusion and independent existence of aqueous vapor in the atmosphere has exerted a very strong influence in moulding the views of meteorologists as to the method by which this portion of the atmosphere operates in modifying meteorological phenomena. Of late years, however, very strong suspicions have existed as to the propriety of carrying Dalton's views to the extreme that has been maintained by many. In fact, so early as 1840, Espy distinctly controverted them. Of late, Hildebrandsson, Hann, and especially Stefan, have more correctly explained the limitations within which Dalton's laws may be applied. According to the latter, these obtain in the case of a mixture of gases only under conditions of static equilibrium, and do not hold when these are in relative motion. Since the vapor of water in the air, in consequence of its continual evaporation and condensation, is always in movement, it does not conform to Dalton's laws. The permanent gases of the atmosphere, especially oxygen and nitrogen, which retain in general the same proportions, are in equilibrium, and do form atmospheres independent of each other, according to Dalton's laws. It necessarily follows that the percentage of dense oxygen must be smaller as we ascend in the air; and, in fact, chemical analysis gives this result.—19 *C*, VIII., 90.

THE TEMPERATURE OF THE AIR.

One of the most difficult problems in all matters relating to the atmosphere consists in the determination of the true temperature of the air; and the errors in these determina-

tions affect very sensibly both astronomical, meteorological, and hypsometric labors. Professor Plantamour was among the first to show that observations of the barometer taken simultaneously at two distinct stations ought to enable us by calculation to arrive at the average temperature of the intervening atmosphere. Among those who have lately applied this method is Mr. Schott of the Coast Survey, who has, from observations made about fifty miles northwest of San Francisco, calculated the temperature of the air between two stations occupied by Mr. Davidson. As the results of these studies, it appears that the average temperature of the air between two stations differing 2000 feet in altitude remained sensibly constant throughout the entire day, as though the sun's rays passed through it without appreciably heating it; while, on the other hand, the thermometer at the two stations respectively rose to a maximum at 1 P.M., and fell to a minimum in the morning and evening. The daily variations of temperature seem, therefore, to be confined mainly to the layer of air in close proximity to the earth's surface. The corrections to be applied to the observed thermometers, in order to obtain the true temperature of the air, varied regularly throughout the day, and are decidedly larger than those obtained by Professor Plantamour at Geneva. M. Schott, in explanation of this phenomenon, suggests that probably the 20 or 30 per cent. of total solar radiation which is absorbed by the atmosphere is consumed in the processes of expansion and evaporation; and thus gives no sensible heat.—*Coast Survey Report, Appendix* XI., 1871.

THE UPPER CURRENTS OF THE ATMOSPHERE.

The upper currents have been much neglected by meteorologists until recent times, when the extensive weather-maps published in Europe and America have enabled proper attention to be given to their study. Some of the important laws relating to the movements of the cirrus clouds were apparently suspected by Redfield, and were in a general way predicted by Ferrel; but extended observations and deductions are due principally to Clement Ley (1872), and more recently to Hildebrandsson, the Director of the Meteorological Bureau of Sweden. This gentleman states that

in December, 1873, he addressed letters to many observers in Europe, soliciting accurate observations on the movements of the cirrus clouds. All the observations were carefully entered by him in the weather-charts of Europe, and compared with the observed direction of the lower clouds, as well as the course of the isobarometric lines. From the entire series of observations accumulated in three years, Mr. Hildebrandsson gives his conclusions as follows: Near the centre of a barometric depression the upper currents move in a direction very nearly parallel to the isobars and to the lower currents; but in proportion as we go from the centre of low pressure they move outward, and deviate to the right of the lower clouds. Within regions of maximum barometric pressure the upper clouds converge toward the centre, cutting the isobars very nearly at right angles. The figures prove clearly that the upper currents of the atmosphere move from the barometric minima, and converge toward the maxima.

In respect to the arrangement of parallel bands of cirrus clouds, our author states that he has inserted upon his charts 171 observations, and finds that the bands of cirri are, within the regions of maximum pressure, generally arranged in directions very nearly perpendicular to the isobars, but in the regions of minimum pressure they are sensibly parallel to the isobars. It follows from his investigation that the air must necessarily be ascending in the region of low barometer, and that, when arrived at a great height above the earth, it removes from this region of low pressure and, spreading uniformly out over the regions of maximum pressure, gradually falls toward the earth in descending currents. In this manner there is effected a continual vertical circulation between the surface of the earth and the upper limits of the atmosphere. The principal agent in this circulation is the difference in temperature and moisture between the lower and the upper regions of the atmosphere — differences which exceed even that between the equator and the poles. Carrying out this idea, Hildebrandsson concludes that the cold experienced at the surface of the earth during areas of high pressure comes from above, being brought down by the descending atmosphere, and explains thereby the anomalous daily period in the determinations of the altitudes by the barometer. The conclusion of his memoir, expressing the

hope that observations of cirrus clouds will in the future be more thoroughly made in connection with weather predictions, has been already, we believe, anticipated, so far as the action of the Weather Bureau of the Army Signal-office is concerned, since its tri-daily maps have shown the movements of cirri ever since 1871, in which year also Professor Abbe announced for America laws precisely the same as those that Hildebrandsson has now deduced for Europe.—*Essai sur les Courants Supérieurs*, 1875.

A VERY DELICATE BAROMETER.

An ingenious device has been constructed by Mendelef, which shows the slightest variations of pressure by means of a small U-shaped tube containing petroleum-oil. One end of this tube is closed, and contains a certain volume of dry air maintained at a constant temperature, while the other end is open to the air. The instrument being accurately adjusted by means of a mercurial plunger connected with the bottom of the U-shaped tube, so that the petroleum is exactly on a level in the two branches of the tube, it is found to be so extremely sensitive that the slightest variation of the atmospheric pressure is shown by the alteration of the relative level, and the amount of this alteration can be measured with the greatest precision.

CONVENIENT FORM OF MERCURIAL BAROMETER.

A mercurial barometer especially convenient for travelers has been invented by Staff Commander George of the British Marine, and is described by Dr. Gurt, according to whom its convenience as well as its excellence consists essentially in the fact that it is filled anew at every station at which it is to be used. The great objection to filling the barometer tube consists in the difficulty of removing every particle of air from the quicksilver in the tube, and securing a perfect vacuum. The operation of boiling mercury is both difficult and hazardous unless the method adopted by Wild be employed. Commander George's method of removing every bubble of air consists in first introducing into the tube a string of cat-gut, on the end of which a feather is fastened, which should reach to the bottom of the tube. The tube is then filled to one third of its height with quicksilver, which

is then set in rotation by rapidly spinning the cat-gut between the fingers, while at the same time the string and feather are slowly drawn up. By this means whatever air adheres to the sides of the tube, or is carried down by the quicksilver, is completely displaced and rises to the surface. More mercury is then poured in, and the operation twice repeated, until the tube is filled. By this means a vacuum is always secured without boiling the mercury in the tube, as is shown by a comparison with the most carefully prepared standard barometers. When the barometer is to be transported, the tube is emptied of mercury, which latter may be carried either in the cistern or in a separate vessel.—*Verhandl. Naturhist. Vereins, Bonn*, XXXI., 266.

THE TEMPERATURE WITHIN THE GREAT GEYSER OF ICELAND.

Mr. Robert Walker communicates to the Royal Society of Edinburgh some measurements made in August, 1874, at the Great Geyser of Iceland, which he visited, although his stay was only for a few hours. During that time he was able to make observations of temperature at twelve different depths, varying from 0 to 77 feet; and the temperatures at these depths increased from 187° at the top to 257° at the bottom, whereas the boiling-points, as calculated by him, would have been respectively 210° and 278° Fahr. He states that his results confirm very remarkably those of Professor Bunsen, obtained during ten days in July, 1846. The difficulty of reaching the place at all will hinder, he thinks, any one from carrying thither accurate apparatus for a more complete series of observations than he was able to make. In a general way he finds, as did Bunsen, that the temperature of the water nowhere reaches the calculated boiling-point; but the deviations therefrom seem to have been far greater in 1846 than in 1874.

No theory of internal caldrons filled in succession with steam and water seems at all consistent with observed phenomena.—*Proc. of the Royal Society of Edinburgh*, VIII., 514.

AWARD TO THE ARMY SIGNAL SERVICE.

In noticing the fact that the recent Geographical Congress at Paris awarded to the United States Army Signal Service

a letter of merit as the highest testimonial, we will also call attention to an admirable *résumé* by Angot of the organization and labors of the Army Weather Bureau. In closing his review, he states that independently of the usefulness of the Signal Service in its own country, "we see that it has a still higher claim upon the recognition of all meteorologists by its 'International Bulletin.' This publication is made on so generous a basis, and distributed with such liberality, that it would suffice of itself to place the Signal Service in the first rank of all the meteorological institutions of the entire world."

"On the occasion therefore of the recent Geographical Exposition, the International Jury was constrained to decree to it its highest award, associating it with two other equally remarkable institutions, whose titles are, however, slightly different, viz., the Meteorological Office of London, and the Meteorological Institute of Utrecht; while these latter two represent the scientific, the Signal Service seeks only the practical, but is also useful to both—to America by its weather predictions and its daily labors, and to the rest of the world by its publications."—8 *B*, *April* 22, 1876, 401.

THE CLIMATE PRECEDING THE GLACIAL EPOCH.

As the result of study into glacial phenomena in Upper Bavaria, Zittel concludes it to be proved that the glacial epoch was preceded by a period of extensive floods, during which immense masses of movable material filled up the inequalities of the valleys and ravines previously excavated in the tertiary deposits, and thus afforded an even surface for the glaciers that were to follow.—*Sitzb. K.-B. Acad. München*, IV., 282.

TABLE FOR COMPUTATION OF RELATIVE HUMIDITY.

In the annual report of the commission charged with the maintenance of the meteorological observatory at the Pic du Midi de Bigorre, a convenient table is given by Hatier, one of the members of the commission, for computing the relative humidity from the indications of the wet and dry bulb thermometer, when the atmospheric pressure at the place of observation differs considerably from thirty inches. Most observers are either ignorant of the fact that the ordinary

tables for computing relative humidity are applicable only for stations at or near the sea-level, or else they neglect to make the necessary correction for altitude, owing to the labor of the computation. The table given by Hatier is perfectly general in its applicability, and enables one to compute the relative humidity, no matter what the barometric pressure may be, and is worthy the adoption of American observers.—*Rés. Obs. du Pic du Midi*, p. 21.

IMPROVEMENT IN ANEROIDS.

Hon. Ralph Abercrombie notes that a decided improvement in aneroid barometers consists in jeweling the ends of the arbor of the index hand like the ordinary pivots of a watch, and making the hands work underneath the cap, instead of in the usual manner. He recommends conical pivots as preferable to straight ones.—*Quar. Jour. Brit. Met. Soc.* 1876, 87.

THE CLIMATE AND TREES OF SACRAMENTO BAY.

An interesting memoir on the distribution of forests and trees in the neighborhood of San Francisco is given by Dr. Cooper in the fifth volume of the Proceedings of the California Academy. He states that the most notable fact in botanical geography is the comparative scarcity of trees as compared with regions to the northward or southward, and, after a careful study of the subject, he concludes that the chief cause of this deficiency is the prevalence of strong winds, which throughout the dry season blow so steadily into the Golden Gate from the northwest, and are drawn by the ascent of hot currents far into the interior, following, generally, the course of the valleys upward from the bay of Sacramento. Where the west winds blow with sufficient force, the tree growth is limited to scattered groups on the eastern slopes of the hills. Elevation above the sea has less effect than would be expected. Trees that are fully developed in unexposed regions dwindle into shrubs in the exposed portions, assuming the aspect of trees stunted by the cold, as on mountain summits. Dryness, however, is still more influential than cold. The general course of the mountain ranges is nearly northwest. The wind strikes the southwest slopes obliquely, and the sun shines on the same

slopes most intensely. These are the slopes that are almost every where destitute of trees, although they receive the greatest rainfall and the most fog. The winds act in two ways: first by their drying power, and second by their coolness; perhaps also by their influence in spreading fires during the dry seasons. The forests are chiefly most extensive on the northeastern mountain slopes.—*Proceedings of the California Academy of Science*, V., 286.

PERIODICITY OF HURRICANES.

In the March and April numbers of the *Revue Maritime et Coloniale*, Vice-Admiral Fleurcote de Langle examines the question of the periodicity of hurricanes throughout the globe; having reference especially to the influence of the sun and of the moon. He concludes that for a given latitude of the earth's surface we can, by knowing the positions of the sun and the moon, compute the probability of experiencing a hurricane on any given day. For this purpose he gives tables based upon a complete analysis of recorded hurricanes, the reliability and usefulness of which is, however, somewhat problematic.—*Revue Maritime et Coloniale*, 1876, 129.

CLOUDS AND WINDS AS OBSERVED FROM BALLOONS.

In some notes on the formation of clouds, Villeneuve states that when the sky is covered with nimbus or cumulus, one always meets on ascending in a balloon with winds moving either in a contrary direction, or crossing each other under variable angles, or if very nearly in the same direction, then with very different velocities; and these winds have very different temperatures. Second, when the sky is without clouds, or we see only cirrus, we find at all altitudes winds moving in the same direction, or, exceptionally, two winds in different directions, but having sensibly the same temperature. In explaining these phenomena, he lays down the rule that the thickness and the form of clouds are functions of three causes: first, the difference between the temperatures of two superposed currents of air; second, the relative velocity of one current over the other; third, the degree of humidity; and it can happen but rarely, he states, that two currents moving in different directions do not pro-

duce clouds at their surface of contact. This occurs, however, only when they are sensibly at the same temperature. He has observed this fact in north winds blowing above east winds; but never in the case of south winds blowing above north winds. Some aeronauts have observed four currents superposed and blowing in different directions. This condition is extremely favorable to the formation of rain. According to Villeneuve, if we could know the temperature of the winds which are superposed above our heads and their hygrometric state, we should be able to announce with certainty whether rain or cloudiness would ensue.—*L'Aéronaute, November*, 1875, 321.

HIPP'S ANEMOMETER.

A description of the anemometer recently invented by Mr. Hipp is given by him in the tenth volume of the Bulletin of the Scientific Society of Neuchatel. The object of this anemometer is to register at any distance whatever the velocity or the total movement of the air. It permits one to determine at any minute the velocity of the wind. The wind acts upon the ordinary Robinson atmospheric cups, and these can be placed at any distance from the registering apparatus, communicating with it by electric telegraph. Clock-work communicates a movement to the long band of paper destined to receive the register. Velocities as high as fifty miles an hour are registered on this band, but the apparatus can easily be enlarged to record the highest velocities that occur in hurricanes.—*Bulletin Soc. des Sciences Naturelles, Neuchâtel*, X., 189.

DUFOUR'S HYGROMETRIC STUDIES.

Dufour has presented to the Society Vaudoise a second memoir on hygrometric diffusion, in continuation of that published in 1874. The following is a general summary of his conclusions:

When a partition of porous earth separates two masses of air in different hygrometric states, there are produced two opposite and unequal currents of diffusion traversing the partition. The greater current flows from the dry to the humid air. The difference of the two currents depends principally upon the difference in tension of the vapor on the

opposite sides of the partition. Temperature has little or no effect. Second. Hygrometric diffusion takes place through plates of marble five millimeters in thickness, homogeneous and compact, polished or not polished; but it is slower in this case than when traversing partitions of porous earth. Diffusion is observed also through gypsum, charcoal, and alabaster, being slowest in the latter case. Third. When a limited volume of air is inclosed in a vase, of which one side is a porous partition, there is produced and maintained between the interior of this vase and the surrounding air a difference of pressure, if the hygrometric conditions are different within and without. The difference of pressure is nearly independent of the thickness of the porous partition, and is attained in a space of time varying with the amount of surface of the partition. Fourth. The difference of pressure that the hygrometric diffusion is capable of producing and of maintaining depends, other things being equal, on the thickness of the partition. For porous earth, the possible differences of pressure are very nearly inversely proportional to the square roots of the thicknesses. Fifth. The current of diffusion attains its greatest velocity when the barometric pressure is the same on both sides of the partition, and is greatest when the thickness of the partition is least. Sixth. When the hygrometric diffusion has brought about a difference of pressure within and without the inclosure, the excess of volume of the prevailing current is diminished in proportion as the difference of pressure increases. This diminution is more rapid according as the partition is thinner.—*Bulletin Soc. Vaudoise, Lausanne*, 1875, 608.

THE SEVERE STORM OF MARCH 12, 1876.

The severest storm that has ever been observed at Brussels occurred on the 12th of March, 1876, on which occasion the barometer fell to a very low point and the wind acquired unequalled violence. Its maximum force, as measured by the pressure anemometer, was 144 kilogrammes per square meter. On account of the exceptional character of this storm, the director of the observatory, M. E. Quetelet, has presented to the Royal Academy of Belgium a special study of its history, development, and progress. Quetelet states

that many documents relating to this storm still remain in the hands of Messrs. Buys Ballot and Scott, who are also occupied in the same study. His memoir is accompanied with a map showing the force of the wind and the barometric pressure at every hour during the day on which the storm occurred. The maximum violence of the wind was attained, as is usual in Europe, a few minutes before the minimum pressure occurred, when the direction of the wind was from west-southwest.—*Bulletin Acad. Roy. des Sciences, Bruxelles, 2d Series*, XLI., *April*, 1876.

BAROMETRIC PRESSURE DURING WINDS.

Montigny communicates to the Academy of Sciences of Belgium an investigation into the law of diminution of pressure in the atmospheric strata when the state of equilibrium is disturbed, especially under the influence of storms. His remarks are based principally upon observations made by him some years ago in order to determine the influence of winds upon barometric altitudes. Having distributed his observations into four classes according as they were made during the periods of high or low, rising or falling barometer, he draws the following results: First. Barometric altitudes measured under the influence of easterly winds are generally less than the true altitudes, and correspond very frequently to epochs of high barometer, and rarely to epochs of low barometer. Second. The altitudes under the influence of east winds are least when the wind is exactly east. Third. The altitudes calculated when west winds blow are generally superior to the true altitudes, and have most frequently been measured under the influence of storm-winds. When, however, the pressures are increasing, the west winds sometimes give especially low altitudes. Fourth. The number of storms with westerly winds is a maximum when the wind is directly west; to which point also correspond the greatest altitudes as computed by barometric observations. Now the theoretical laws, according to which altitudes are computed barometrically, are rigorously true only when the air is calm. We should then conclude that under the influence of storms the diminution of pressure in the layers of air is more rapid as we ascend vertically than when the air is calm; and, again, that this diminution is more rapid when

the barometric pressure is diminishing under the influence of west winds; but when the atmospheric pressure is increasing during the prevalence of an east wind, barometric altitudes are less than the true altitudes; or the diminution of pressure in the successive strata of air is less rapid than when the air is perfectly calm.—*Bulletin Acad. Roy. des Sciences, Bruxelles*, 1876, 757.

CLIMATIC CHANGES IN SCOTLAND.

Mr. Buchan communicates to the Botanical Society of Edinburgh a short note on the bearing of meteorological records on the supposed change of climate in Scotland. He states that Mr. McNabb, in 1873, defended the popular theory that the climate of Scotland affords cooler summers and warmer winters than formerly, basing his support upon the facts deduced from vegetable phenomena. Mr. Buchan himself, however, examines the question solely with reference to the recorded monthly mean temperatures as observed since 1781, in two districts—one in the north and one in the south of Scotland. The records show plainly that, as regards temperature, the weather of December is subjected to large fluctuations, but there is no tendency to a permanent increase or decrease of temperature; and similarly with the temperature of July. Exceptionally warm and exceptionally cold months are distributed throughout the whole ninety-four years, in such a way as to show that no permanent change has taken place in the temperature of any month, or of the year. As an instance, however, of the remarkable fluctuations which occur, he adds that during the past seven years the temperature of July has been above its average, and that of December has been below the average. These variations are quite in the opposite direction to that required by the public belief.—*Transactions Botanical Society of Edinburgh*, 1874, 250.

THE ANEROID BAROMETER.

An excellent series of papers has been presented to the scientific society of Chemnitz by Professor Schreiber. His first article relates to the construction of the aneroids of Bourdon, Naudet, and Goldschmid, and the construction of an apparatus for testing aneroids without an air-pump. The

examination of aneroids under the receiver of an air-pump has been attempted by Stewart and by Lovering; the comparison of an aneroid with a quicksilver barometer, by carrying both together to high altitudes, has been attempted, among others, by Holtschl. But all these attempts are unsatisfactory, and Schreiber has substituted therefor the following method: An iron receiver is made, in which the aneroid is placed, and which can be closed hermetically by a glass plate. The receiver is then connected with a manometer, so that air can flow in, and furnished with a stopcock, so that air can flow out. The changes of pressure of the air within the receiver are brought about by changing the temperature, which may be elevated to 50° Centigrade, or cooled to —20°, by which means pressures of from 730 to 570 millimeters can be attained. At the higher temperatures successive gradations of pressure are obtained by allowing the expanded air within to escape little by little through the proper cock. In a second paper, Schreiber considers the influences of changes of gravity upon the difference between the aneroid and the mercurial barometer, in which he combats the somewhat absurd theories of Herr von Wullerstorff-Urbair, who, besides a correction for gravity, suggests also a correction for terrestrial magnetism. The unimportance of the latter correction is proved by Schreiber, by simply causing the steel index-needle of the aneroid to be strongly magnetized, in which condition, however, no alteration took place in the reading of the instrument. The latest forms of construction of the aneroids suggested by Kohlrausch, Weilenmann, and Reitz are also elucidated by Professor Schreiber.

In a third communication, Schreiber explains a method of using the results published by Ruhlmann on barometric hypsometry, showing that in Saxony, at least, hypsometric measurements can be made without determining the temperature of the air at the time of observation, but by using the mean daily temperature.

In a fourth communication, Schreiber treats of the differences between the pressure of the air in buildings and in the open air, as brought about through the suction or pressure produced by the wind blowing into or past open windows. Similar effects have been observed and studied by James

and Bache. Schreiber's observations were made in three places at the same altitude, two within houses and the third in the open air. In calm weather the pressure at all three places was the same. As soon, however, as the wind blew even with moderate force the pressure within the house was always lower than in the open air. It was also noticed that in the house the pressure oscillated with the strength of the wind, and every gust of wind was accompanied with a corresponding fall in the barometer; while in the open air the barometer remained quiet. The barometric depression within the house was quite considerable, amounting to one quarter of a millimeter for a velocity of six meters per second, and 1.15 millimeters for a velocity of 18 meters per second. —*5th Bericht Naturw. Gesellschaft, Chemnitz*, 1875, 17–22, 26–36.

A NEW FORM OF HYGROMETER.

Among the new forms of the hygrometer, are noted those as made by Lambrecht according to the plan and under the supervision of the inventor, Klinkerfues, of Göttingen. The method of construction of this instrument is not made public, but it is stated that it is always compared with the psychrometer, and that in every respect it is exceedingly trustworthy.—*Giebel's Zeitschrift ges. Naturw.*, 1875, XII., 300.

THE FORMATION OF SNOW AS OBSERVED FROM BALLOONS.

In a balloon ascension on the 29th of November, 1875, Tissandier observed that the fall of small crystals of snow which prevailed at the earth's surface ceased after reaching a moderate altitude. At 700 meters above the earth's surface the temperature was −2° Centigrade. At this altitude a thick cloud spread over the earth's surface, having a vertical depth of 800 meters. Within this cloud the temperature sank to −4° Centigrade. At 1500 feet above the upper surface of the cloud was found a stratum of ice crystals to the depth of 150 meters. Above this the temperature of the air was 0. The snow crystals had a very remarkable appearance; and the rise in temperature at this altitude depended undoubtedly upon the formation of the crystals and the evolution of latent heat.—19 *C*, 1876, 66.

RIVER CURRENTS AS AFFECTED BY THE EARTH'S ROTATION.

In Dr. Giebel's *Zeitschrift*, Dr. Dunker gives a somewhat elaborate essay on the influence of the rotation of the earth on the course of rivers, in which, after referring to his first memoir published in 1860, he refers to that of Von Bayer on the same subject, and states that his conclusion that rivers flowing either northward or southward in the northern hemisphere should have their right-hand banks steeper, higher, and more rapidly eaten away, applies also to the southern hemisphere, with the exception that there the left-hand banks are affected in that way. The further consideration of this subject leads him to the consideration of the movement of the winds on the earth's surface, and he gives a general formula, published first by Hollbaur, as applicable to the movement of any body on the surface of the earth, whether solid, gaseous, or liquid. Dr. Dunker seems to consider only bodies moving in the meridian either northward or southward, and treats at some length of the influence of the river in excavating and changing its channel.—*Giebel's Zeits. ges. Naturw.*, 1875, 463.

THE INTERNAL TEMPERATURE OF THE EARTH.

The origin of the interior heat of the earth is treated of in a few words by Professor Mohr, who states that if the interior is still molten, it follows that the nearer we approach this nucleus, not only must the temperature increase, but must do so in an increasing ratio; so that for a given increase of temperature we require to penetrate into the interior of the earth through a decreasing number of feet. Now the deepest artesian well as yet executed is at Sperenberg, about twenty miles south of Berlin. This well was begun in 1867, and has already reached a depth of over 4000 feet, at which depth Magnus measured the temperature (38.5° Reaumur) by means of his geothermometer. The observations of temperature that have been made in this well were executed with the greatest care; each position of the thermometer being cut off from connection with the upper or lower portions of the well by plugging up the tube. The most probable results of these measures are given in the following table:

Depth. Prussian Feet.	Temperature. Reaumur.	Depth. Prussian Feet.	Temperature. Reaumur.
700	15.654°	1700	25.623°
900	17.849°	1900	27.315°
1100	19.948°	2100	28.906°
1300	21.931°	3390	36.756°
1500	23.830°	4052	38.500°

There results from these measurements a very remarkable but well-established result—that the rate of increase of temperature is continuously growing less as we descend. This increase diminishes at the rate of one twentieth of a degree for every hundred feet, so that it is easy to compute at what depth the temperature will cease to increase. This depth is found to be the very moderate one of 5190 feet, at which a temperature of about forty degrees might be expected to prevail. Even if we do not attribute absolute accuracy to these observations, yet we see that a constant temperature must be attained at a depth far within twenty miles; and that the temperature itself even at that depth must be far less than the melting-point of the rocks. The result of these observations at Sperenberg is therefore completely in accordance with those deduced by Vogt from operations at the artesian well at Grenelle; and if we attribute any value at all to these calculations, they seem to give a death-blow to the Plutonic theories of former geologists.—*Verhandl. Naturhist. Vereins, Bonn*, XXXI., 267.

EARTH TEMPERATURE AT KÖNIGSBERG.

The results of a series of measurements of the temperature of the earth, as made at different depths in the botanical garden at Königsberg, has been communicated by Dr. Dorn to the Physical and Economical Society of that city, who remarks that while the series is of too short a duration to justify a very extended investigation, yet one thing is remarked, viz., that the annual mean temperatures as derived from the deeper thermometers are invariably lower than those derived from the surface thermometers instead of being higher, as is usually the case. This anomaly, however, is abundantly explained if we consider that the winters of the years 1869, 1870, and 1871 were of an exceptionally low temperature; and this wave of cold had, in 1873, only just reached the depths in the earth at which the lower thermometers were placed,

while the upper thermometers during that year were exposed to an unusually mild temperature.—*Schriften Ostpreussische physikalisch.-ökonom. Gesells., Königsberg*, XV., 18.

THE INTERIOR STRUCTURE OF THE EARTH.

The mode of formation of the inequalities of the earth's surface forms the subject of a thorough study by Osmond Fisher, in a memoir published in the twelfth volume of the Cambridge Philosophical Transactions. He concludes that the molten earth first solidified from the centre, and, after a time, from the surface also; so that there is probably at present a thin layer of molten material between the solidified crust and the solidified interior; and that the solid crust therefore rests in corrugations upon a liquid or quasi-liquid layer. The conditions of equilibrium of such a crust are, first, that it must be considered flexible; second, it must be in unstable equilibrium; and, third, therefore oscillations of the surface are possible. Mr. Fisher makes an approximation to a rigorous mathematical investigation by inquiring what form would be assumed by a heavy, flexible crust resting upon a liquid in a rectangular trough shorter than the crust; and shows that when any extraneous force acts upon the crust, it will assume the form of a series of equal circular arcs. The same conclusion holds good when the trough is supposed to be very long, and opened lengthwise into a circular form corresponding to the surface of the earth.

The further conclusions of Mr. Fisher are expressed in the mathematical equations introduced by him. — *Cambridge Philolophical Transactions*, XII.

THE THERMAL SPRINGS OF THE UNITED STATES.

A very complete list of thermal springs in the United States, with the temperatures of their waters as far as they have been observed, is given by Mr. G. K. Gilbert, of the Survey of the Territories West of the Mississippi. He considers the thermal springs as being a valuable indication of the method by which inequalities of the earth's surface have been formed. Hot springs are generally found where the rocky structure is such as to admit of easy communication with subterranean waters. Tilting and fracture of strata are

concomitant features of mountain corrugation; and in regions of such corrugation we should look for thermal waters. Designating upon a map the localities of the numerous springs reported by Mr. Gilbert, the first thing noted is that the Mississippi Valley contains no hot spring, nor do the plains of the Atlantic coast. Among the Ozark Mountains of Arkansas we have one. In the Colorado Plateau five localities are noticed. The distribution of hot springs is found to coincide very exactly with that of corrugation. The range of temperature of the waters is far higher in the western region than in the eastern.—*Hayden's Survey and Reports*, 1876, 145.

CONNECTION BETWEEN SOLAR SPOTS AND TERRESTRIAL ELECTRICITY.

As the result of his study upon the frequency of thunder and lightning storms in Germany and Switzerland, Von Bezold concludes it probable that high temperature as well as a solar surface free from spots are the conditions bringing about years rich in electrical displays. Since, however, the maxima of solar-spot surface agrees with those of greatest intensity of the auroras, it follows that both kinds of electrical phenomena, thunder-storms and auroras, are in a certain manner complementary to each other, so that years rich in thunder-storms are poor in auroras, and *vice versa*. Such a connection between sun-spots and thunder-storms implies, however, by no means the assumption of a direct electric interchange between the earth and the sun, but can rather be considered as a consequence of the variable solar insolation as dependent upon the solar-spot surface. The variations of insolation, according to Köppen, are not felt simultaneously, but rather successively in the various latitudes of the earth. The thunder-storms depend not only upon the temperature of the place of observation, but also upon the condition of the atmosphere at points far distant and belonging to other climatological zones, as is best seen in the thunder-storms accompanying extensive storms. In this way perhaps can best be explained the peculiar position which the curve of thunder-storm frequency holds between the solar-spot curve and the temperature curve.—*Sitzb. K.-B. Akad. der Wissens., Munich*, 1874, IV., 318.

THE FORCE OF SEA WAVES.

In connection with a memoir on the Manora Breakwater, read before the Institution of Civil Engineers, London, by W. H. Price, some remarks were made by Mr. David Stevenson and others on the effect of sea waves in breaking up heavy masses of masonry. A remarkable instance of the power of such waves was afforded in the case of the breakwater at Wick, on the coast of England. The height of the waves at this place was several times measured and estimated, the result being about forty-two feet from crest to hollow. Stones of eight and ten tons' weight were by such waves carried from the parapet to the top of the breakwater. It was resolved finally to construct the outward extremity of the breakwater by depositing three courses of one-hundred-ton blocks of stone on the rubble base, as a foundation for three courses of large flat stones, surmounted by a monolith of cemented rubble built on the spot. The end of the breakwater, therefore, was in substance a monolith weighing upward of eight hundred tons, being about 26 feet by 45, and 11 feet in thickness, cemented to the underlying rubble base. Incredible as it might seem, this huge monolithic mass succumbed to the force of the waves. It was actually seen by the resident engineer to be bodily slewed around by successive strokes, until it was finally removed and deposited inside of the pier. In fact, not only the upper portion, but the three lower courses of stone, forming a mass of 1350 tons, were removed without breaking.—*Minutes and Proceedings Institution of Civil Engineers, London*, 1876, 40.

CLIMATE OF THE CAUCASUS.

Dr. Radde, in some remarks on the geology of the Caucasus, shows that the physics of the surrounding land is rendered entirely different by the presence of these great mountain ranges. The limit of perpetual snow in the Caucasus sinks to ten thousand feet in the moist districts of Colchis, but rises on the northern side of the Caucasus, where the dry east and northeast winds prevail, and where there can be only a slight precipitation of snow, until on Mount Ararat, even at the height of 14,300 feet, vegetation is found. There is, therefore, a difference of at least 4000 feet in the

limits of perpetual snow in different portions of the Caucasus. The culture of the vine succeeds without special protection in winter at an altitude of 3600 feet in Colchis, while on the east side of Mount Ararat, even at the height of 3000 feet, the vines must be protected in winter.

Over a hundred hot springs are known in the Caucasian range; and, according to Radde and Abisch, the distribution of these springs is independent of the extensive volcanic activity that exists in the former geological peaks. On the other hand, the springs as well as the volcanic phenomena are distributed in cognate methods along the dividing lines of axes of elevation and dislocation.

The most remarkable collection of mineral springs is at Pjatigorsk, where within the space of twenty-five square miles every possible kind of mineral springs is found: sulphur springs, alkali springs, iron springs, and muriatic-acid springs, all of which are abundantly visited by invalids.—*Sitzungsb. Ostpreuss. physikalisch-ökonom. Gesells., Königsberg*, p. 8.

THE EASTWARD PROGRESS OF STORMS.

Robert Tennant, Esq., has endeavored to elucidate his views on the causes by which storms progress in an easterly direction. According to him the barometer rarely indicates the pressure due to the weight of the air directly above it; but owing to the sluggish currents at the surface of the earth and the rapid currents above, the pressure is diminished at the surface of the earth, although it may remain undiminished at higher altitudes. When in consequence of high winds the barometer falls, a spiral inflow then takes place toward the centre. This inflow is unequal on the different sides, being for Great Britain less on the east and northeast side, and greatest on the southwest side, in consequence of which the centre of the barometric depression moves eastward. As regards the truth of his statement that the barometer can not give a true indication of weight when the atmosphere is in motion, there can be no doubt; but the exact amount of the diminution of pressure, as calculated by well-known formulæ, is probably much less than that assumed by Mr. Tennant.—*Proceedings Royal Society, Edinburgh*, VIII., 612.

HAIL-STORMS IN FRANCE.

Sales contributes a pretty full study upon certain hail-storms which visited France in June and July, 1874, of which that which occurred on the 28th of July was especially remarkable. Two occurred on the 26th of June, covering quite distinct sections of country, between which there seemed good reason to believe that some connection existed, although its exact nature is not indicated by the theory. Very curious are the isolated points observed by him at which hail fell apparently without any connection with other more extensive hail-storms occurring at a distance. The principal object of his inquiry has been the connection between hail-storms and altitude above the ocean. In general the hail begins in the valleys, and rarely is observed at stations more than one thousand feet above the sea; which limit seems to offer insuperable obstacles to its formation in France, although not in America, where the heaviest hail-storms occur at higher altitudes.—*Mém. Acad. des Sciences, Toulouse*, 1875, 285.

RED SNOW ON THE PIC-DU-MIDI.

The establishment by the United States of meteorological observatories on Mount Washington and Pike's Peak seems to have stimulated the action of other meteorological offices in the same direction. Thus, in France, the observatory on the summit of Pic-du-Midi has formed quite an epoch in meteorological study. A number of interesting results, drawn from the first year's observations, are presented to the Academy of Sciences of Toulouse by Dr. Armieux, who specially calls attention to the hypsometric results, and to the peculiarly interesting phenomena of red snow. After a short historical survey of our knowledge of the red snow, to which he himself had previously contributed somewhat in his article "Topography of the Sahara," published at Algiers in 1865, he shows that the presence of red snow on the Pyrenees has been established beyond doubt. It has therefore thus far been observed both here and also in the Alps, Spitzbergen, Greenland, and New Shetland, and in the antarctic zone, to which we may also add an occasional record of its appearance in North America. From the draw-

ings and description of the red coloring particles as seen under the microscope of Dr. Armieux, it is evident that with the red particles are mixed occasionally green ones; and the cryptogamous nature of the substance is placed beyond a doubt.

The explorers in the Swedish North Pole expedition have seen marine algæ growing and fruiting at a temperature far below zero, while at higher temperatures the spores completely disappeared. There are therefore some vegetables which can only live in intense cold and continuous dryness; and to these the cryptogams of the red snow must be nearly allied. Many of the figures observed by Armieux bear close analogy, he states, to those figured by Cohn in his beautiful memoir published at Breslau in 1872; whence he concludes an intimate relation between the *Protoccocus nivalis* and the *Protoccocus pluvialis.—Mém. Acad. des Sciences de Toulouse*, 1875, 195.

THE WINDS AND RAINS OF INDIA.

A valuable memoir on the winds of Northern India, presented by Henry Blanford, of Calcutta, to the Royal Society of London, has recently come to hand, in which this subject is treated of in the fullest and most admirable manner. He first describes the general scheme of the wind system of Northern India, in which he shows that it is very different from that of the adjacent seas. Instead of two monsoons from northeast and southwest prevailing alternately during about equal periods of the year, we find a great diversity of prevalent wind currents depending upon the direction of the mountain ranges and of the great valley plains; and with respect to period to be classified under three rather than two distinct seasons, excepting, indeed, in Upper Assam, where the normal monsoons prevail. In the cold weather months, from November to January, the wind appears to flow in a gentle current from a distinct source in the hilly regions southward, down the valleys of the Indus and Ganges, or across the water-shed of Central India. In hot weather the winds draw around to the westward, and dry currents radiate out over the whole region, and, becoming heated, form the well-known hot winds of April and May. These winds, however, are essentially diurnal winds. In June

the southwest monsoon sets in on both coasts of the peninsula.

The relation of the winds to temperature, humidity, and barometric pressure is most carefully presented in detail. In a general summary he states that the northeast monsoon of the Indian seas is produced by the cooling and condensation of a comparatively calm atmosphere over the land surface of India. Its origin is in the plains of the Punjab, and Upper and Central India and Assam, probably also on the southern slopes of the Himalaya. These wind currents are fed by an upper current which he terms the *anti-monsoon*, of which he traces two distinct branches.

The double system of upper and lower currents is presented by him in admirably constructed charts, on which both are shown in their proper relations to each other. The southwest monsoon is produced by the heating of the land surface of the peninsula. As the heat increases the pressure falls steadily, and the sea winds are drawn from a greater distance south. At length, in general, the ridge of high pressure over the sea, which has been steadily receding southward since February, is obliterated, and the southeast trade, or perhaps only a portion of it, crossing the equator, brings the monsoon rains to Bengal and the western coast of India.—*Phil. Trans. Royal Soc. of London*, CLXIV., 363.

ORIGIN OF CYCLONES.

The origin of the cyclones of the Bay of Bengal has been studied by Blanford, of Calcutta, who concludes that they are not necessarily produced by two parallel currents blowing in opposite directions, but rather that a calm state of atmosphere, or one in which the winds are light and variable over an open sea, is a condition favorable to the formation of these storms; and that a second condition is high or moderately high temperature. In consequence of this collocation, a large quantity of vapor is produced, ascends into the atmosphere and is condensed, with a liberation of its latent heat over the place of its production instead of being carried to some distant region. The atmospheric pressure is thus locally lowered, tending to cause an indraft of air. The formation of cyclones is, then, finally determined by an inrush of a saturated storm-current of air from the southwest or

west-southwest. This latter feature may possibly be one peculiar to the northwest portion of the Bay of Bengal; and Blanford especially guards himself against being supposed to extend these views to the case of any other area than that which he has especially dealt with.—*Phil. Trans. Royal Soc. of London*, CLXIV., 563.

DRY THUNDER-STORMS.

A correspondent in Oregon, Missouri, states: "When the earth has become dry, parched, and very warm, I have often, on the occasion of thunder-storms, noticed for hours, while it was thundering very hard, a mist falling from the storm-clouds, and roll back, after nearly reaching the earth, in the form of lighter vapor. I think this rain or mist in falling passed down to the stratum of very hot air on the earth's surface, and became a steam; large volumes of white vapor, forming suddenly, and rolling back and up. Now I am confident that if the earth had been shaded by trees this rain or mist would have fallen on the ground. This phenomenon can be seen here every hot, dry season. My attention was called to it by a question asked while one of these dry thunder-storms was prevailing—the thunder rattling overhead, and not a drop of rain falling. The white mist is not easily observed overhead, where all is light, but opposite the sun under a dark storm-cloud it is very plain, and must attract attention."—*Appleton's Popular Science Monthly*, IX., 765.

TEMPERATURE OBSERVATIONS IN ITALY.

The distribution of temperature in Italy is the subject of an elaborate memoir by Ragona, as published in the supplement to the Italian Meteorology for 1876.

Starting with the annual movement of the sun, Ragona passes to the remarkable formulæ that have been published by Liaias, Schmidt, Waltershausen, and others, by means of which the distribution of temperature over the whole earth is represented in a very conspicuous manner. The still more remarkable work of Forbes on this subject seems to have been unknown to him. The detailed study of temperature at Modena from the observations of ten years afforded him an opportunity to make many interesting connections between

temperature and other correlated phenomena, as, for instance, the appearance of the auroras of the 4th of February, 1872, and the 4th of February, 1874.—*Meteorol. Ital., App.*, 1875.

RAINFALL, WINDS, AND PRESSURE IN ITALY.

The distribution of rain in Italy for the years 1871 and 1872 is the subject of an elaborate memoir by Denza, in which, after a careful discussion of actual observations of rainfall and evaporation over the whole of Italy, he considers the theoretical question of the cause of the peculiarities of the distribution of rain in Italy in general, and especially in 1872, and has elucidated the distribution of the winds in Italy. Denza adds to the memoir on rainfall one on the distribution of barometric pressure, as shown by the averages of 1870 to 1875.—*Meteorologia Italiana, Supplement*, 1875, 41.

THE BORA OF SOUTHERN RUSSIA.

Baron Wrangell has written a very interesting paper on the causes of the Bora, or northerly gales, at Noworossisk. This place, situated on the Black Sea, would, it is said, have the finest harbor in the East, were it not for its exposure to the strong north winds. According to Wrangell, this wind gains most of its force in that locality from the fact that it is a cold wind flowing down the mountain-sides; and as we can not prevent cold dry air from becoming colder by radiation under a clear sky, he proposes to diminish the violence of the wind by cutting a passage through a spur of the mountain in such a way as to relieve the mass of air behind from any confinement whatever, so that the moment a slight increase of density takes place that air will flow away quietly through the artificial valley. The approximate formula deduced by him for computing the velocity of the wind, when the temperature of the air and the barometric pressure are given, is derived from an ingenious course of reasoning, and gives a close approximation to the observed true velocity.—*Wild's Repertorium*, 1875.

FREQUENCY OF THUNDER-STORMS IN EUROPE.

An investigation into the frequency of thunder-storms during the summer months in Europe has been made by Von

Bezold, who is led to the conclusion that the phenomena of thunder-storms show, in general, during the summer months in the northern hemisphere, two maxima. These maxima approach each other in proportion as we go away from tropical regions. They are scarcely distinguishable in Germany, but are recognized by taking advantage of the observations in Barnaul and St. Petersburg. Of all the stations examined, only one, Katherineburg, shows a single maximum, and the climate of this station is certainly, on many accounts, to be considered as influenced less by the meteorological conditions of the tropical zones than almost any other point in Europe. It is considered therefore that we shall not go far wrong if in the two maxima of electric phenomena, which is so plainly seen in Europe, we recognize an echo of the two summers, or the two maxima of temperature experienced in the tropical zones. — *Sitzb. K.-B. Akad. der Wissens., Munich*, 1875, 220.

CONSTITUTION OF THE ATMOSPHERE OVER THE LIBYAN DESERT.

Pettenkofer has examined the air brought back from the Libyan Desert by Dr. Zittel, the companion of Dr. Rohlfs, with respect to the quantity of carbonic-acid gas contained therein. He finds that the atmosphere in the desert has precisely the same chemical constitution as in Germany, where the quantity of carbonic-acid gas varies between two and a half and five ten-thousandths. He has also examined the air contained in the water of springs, and finds the same agreement. — *Sitzb. K.-B. Akad. der Wissens., Munich*, 1874, IV., 339.

EFFECT OF TIDES ON THE ROTATION OF THE EARTH.

Mr. Tylor, in some remarks on a new theory of tides and waves, advocates the view that the level of the ocean is nearly represented by high-water mark on coasts and bays where there is free access of the tide, or in a channel without a constant flow. He states that he entirely disbelieves in tidal action having the smallest effect on the rotation of the earth, and that the assumption of a great heap of water traveling in one direction is a gross error. He also suggests that some geological difficulties, such as the evidence that tides

during the quaternary periods were three or four times as large as at present, may be explained by periodic changes of position of part of the interior of the earth, rather than by supposing great changes in the distance of the moon from the earth.—7 *A*, XLVIII., 204.

THE DIMINUTION OF WATER IN SPRINGS, RIVERS, AND WELLS.

The report of Wex on the diminution of water in wells, etc., presented to the Austrian government in 1873, was followed by the appointment, at his request, of a commission of engineers, to whom was intrusted the duty of carefully investigating the points raised by the author in his learned memoir. So important did the matter seem, on account of the long-matured views presented by Wex, that the commission decided to fully investigate the matter. The rivers Danube, Rhine, and Elbe were respectively assigned to certain engineers, while others made measurements in relation to the Alpine streams and the glaciers, and others again undertook a special study of the meteorological questions involved.

During the past two years the committee has accumulated a great mass of valuable material, and has presented a very elaborate report on the subject, which was published in a recent number of the Journal of the Austrian Engineers and Architects' Association. The many details given in the report of the committee may perhaps be summed up as follows: First, an increase is proved in the frequency and the heights of floods in the rivers, as well as a diminution in the altitude of the mean of low waters in most of the rivers and streams of cultivated lands; and all the evil consequences depicted by Wex follow thereon; second, the cause of the injurious changes in the regimen of the rivers, in the drainage of swamps and morasses, in the sinking of lakes and dikes, is principally to be found in the destruction of the forests. These two points having been abundantly established by a large corps of able engineers, the conclusions and the recommendations of the Austrian committee become of the greatest interest to other nationalities, since it is evident that the same causes are at work elsewhere, and especially so in America, to bring about the same disastrous results. The committee recommend that on the one hand exact measures be made of all that relates to the hydrography of the

land, implying, of course, the establishment of a permanent hydrographic commission; second, that the most stringent laws be enacted to prevent the willful unnecessary destruction of forests; and, third, that every thing be done that is possible to encourage the planting and cultivation of forests; and, finally, that the streams and rivers, as they at present exist, be connected into a system by means of which the height of the water may be regulated, and the traffic therein facilitated as much as possible.—*Zeitschrift des Ingen.- und Architekten-Vereins*, p. 137.

MAGNETIC PARTICLES IN ATMOSPHERIC DUST.

The atmospheric dust examined by Tissandier was collected in several different ways, and in every case was found to contain minute magnetic ferruginous particles. Part of the dust was collected upon sheets of paper exposed to the air for many days; in another series of experiments air was passed through pure water, and the latter evaporated over sulphuric acid in vacuo. Other samples were collected from rain and snow water, in one instance, particularly, from snow gathered upon Mont Blanc, 2712 meters above sea-level. The ferruginous particles occurring in these various specimens of dust were extracted by means of a magnet and subjected to microscopic examination. In diameter they rarely exceed $\frac{2}{100}$ of a millimeter, and appear to consist of magnetic oxide, resulting from the combustion of iron. Tissandier believes them to be of cosmical, not terrestrial origin, and regards them as the *débris* of meteoric masses.—6 *D*, 1875, *Oct.* 4.

ON THE HEIGHT OF THE AURORA BOREALIS.

In discussing observations made by himself upon the aurora during the Swedish expedition of 1868 to the North Pole, Professor Lemström, of Helsingfors, states that although Loomis, and even Bravais, believed that observations which give a very low height to the aurora are erroneous, and the result of some illusion, yet he can not agree with them; and he offers in support of his opinion, among other things, the phenomena observed on the 18th of October, 1868, at the entrance of the Norwegian Archipelago, when the whole horizon was covered with rays which were soon united around the magnetic pole, forming a regular crown.

All the phenomena that he has observed and described in regard to the illuminated edges of clouds show very plainly that in these cases the polar light was produced in the region of the clouds, and even lower. We know by numerous observations that the number of thunder and lightning storms diminishes considerably as we approach the polar regions, so that they no longer occur in the latitude of 70°. Must we then conclude that in these regions the clouds are completely deprived of electricity? Certainly not; but only that the electrical discharges are made in some other way. In these high latitudes, electricity is discharged not only by clouds, but also directly by damp air, as takes place in the winter in the temperate zones. A great many direct observations prove the existence of slow discharges of this nature; and a very remarkable confirmation is given by Angström, who on one occasion proved the presence in the spectrum of the yellow or auroral ray over almost the entire sky.—*Smithsonian Rep.*, 1874, 232.

RELATION OF THE PHASES OF THE MOON TO ATMOSPHERIC PRESSURE.

In a memoir by Ludicke, he shows that the atmospheric pressure diminishes with the waxing and increases with the waning moon. The pressure is less at the perigee than at the apogee, and in general the effect of the moon upon the atmosphere is the inverse of that which it produces upon the ocean. The observations on which his results are based extend over eight years; but the actual effect of the moon upon the barometric pressure, although decided, is yet exceedingly small.

IRON IN ATMOSPHERIC DUST.

As the result of an examination of atmospheric dust, the mineral residuum from the melting of snow, etc., with special reference to iron in the atmosphere, Mr. Young remarks that this metal, in appreciable quantity, occurs in the dust accumulated in old buildings during a long period of time, and is usually of a globular form, showing that it has been formed at a high temperature. The iron as found in melted snow is much more irregular in shape, and is more abundant in proportion when the snow is collected at the lower levels. Mr.

Young has not been able to establish the occurrence of iodine in snow-water, as claimed by other experimenters. — 6 *B*, 1876, *July* 17, 242.

SCHOTT'S TABLES OF ATMOSPHERIC TEMPERATURE.

An important work has recently been issued by the Smithsonian Institution, entitled "Tables of Atmospheric Temperature in the United States," by C. A. Schott. The special result reached by Mr. Schott, in reference to secular variations of temperature, are of such general interest and importance that we quote some of his conclusions: "The character of the secular variation in the mean annual temperature is that of a series of irregular waves representing a succession of warmer and colder periods. These undulations, when computed for a number of stations exposed to similar climatological conditions, are seen to have approached to parallelism over large tracts of country. There is, however, nothing to countenance the idea of any permanent change in climate having taken place, or being about to take place. During the last ninety years the thermometric records of mean temperatures show no indication whatever of a sudden rise or fall." A similar conclusion has also been reached by Mr. Schott in reference to the rainfall. "If, now, we group together stations properly located, the undulations become well marked, the interval between successive *maxima* or *minima* being about twenty-two years on the Atlantic coast and seven years in the Mississippi Valley. Even these undulations, however, are not sufficiently regular to serve as a basis of prediction. A comparison of the temperature with the frequency of the solar spots show, so far as these records go, no traces of any direct connection between these phenomena. On comparing the temperatures and the rainfalls, there seems some ground for concluding that years of high mean temperature have also a large rainfall. And, again, for years of low temperature the winds appear to be northerly, and for high temperature southerly. The connection between the temperature, the rain, and the winds must, however, be ultimately considered as due to variations in solar radiation."

C. GENERAL PHYSICS.

THE RELATION BETWEEN GRAVITATION AND ENERGY.

In a paper on the relation of the law of gravitation to the principle of the conservation of energy, Rev. George P. Young, of Toronto, proposes to show that if this principle be accepted, it must follow that the force of gravitation, which, at ordinary sensible distances, is one of attraction, must at a certain limit necessarily undergo a transformation into a force of repulsion. He concludes, moreover, that there is a higher law than that of conservation of energy, which law is expressed by him in certain mathematical formulæ, from which he deduces both the law of gravitation at ordinary limits, and the law of repulsion within certain limits.—*Canadian Journal of Science*, XIV., 589.

THOMSON'S DEAD-BEAT ARRANGEMENT FOR CHEMICAL BALANCES.

In giving an account of Sir William Thomson's arrangement for lessening the vibrations of delicate chemical balances, Professor Tait states that this method consists in suspending from the beam two very light closed cylinders, which fit closely, but without touching, into two fixed cylinders open at the top. This apparatus, when applied to a long and massive beam which ordinarily vibrated for some minutes when disturbed, brought it to rest in three half vibrations. There is therefore practically no limit to the length and consequently to the sensibility that may be given to the balance beam.

An instructive aero-dynamical phenomenon is noted by him in this connection, viz., the closed cylinder, when exactly balanced inside of the open cylinder, can be made to ascend briskly by a current of air, even when the latter blows vertically downward upon the centre of the upper end of the cylinder.—*Proceed. of the Roy. Soc. of Edinburgh*, VIII., 491.

SIMPLE DYNAMOMETER.

Dr. Hamilton, of the Long Island College Hospital, mentions that, having a necessity for a dynamometer for therapeutical

purposes, he devised the following construction: A glass tube dips into a bulb of pure India rubber. The interior of the bulb is filled with colored water, which, by pressure upon the bulb, is forced up in the tube, the upper part of which is filled with air, which is thereby compressed. Attached to the tube is a scale whose divisions represent pounds. As fifteen pounds' pressure to the square inch is required to compress the given body of air to one half its volume, of course that amount of force brought to bear upon the bulb will press the column of water half-way up the scale. This apparatus, besides the advantage of simplicity, cheapness, and great accuracy, has the further convenience that the bulb receiving the pressure is of a convenient shape, and can be used by persons of large or small hands. Again, the bulb is adapted to receive pressure exerted by all the flexors of the hands, and, finally, the action of the muscles is the same at different times, the same group of muscles being always brought into play, so that correct comparative tests may be made from day to day.—*Psychological and Medico-Legal Journ., April*, 1875, 256.

ON THE ELASTICITY OF ROCK-SALT.

Some physical experiments have been made by Professor Groth, of Strasburg, upon the elasticity of rock-salt. They involved, first, the preparation of rods of crystalline salt, some three inches in length and one fiftieth of an inch in thickness; these were made perpendicular to the plane of the cube, and also to the dodecahedron. For the determination of the coefficient of elasticity the rod of salt was fastened to a much longer rod of brass, and then set in vibration in the usual way; sand strewed on the vibrating rods determined the position of the nodes, and these in connection with the thickness gave the elasticity of the salt relatively to the brass. By comparing two rods, made as described, the effect of the intervening brass rod was eliminated, and the coefficient of elasticity for the two determined. The ratio obtained was 1 to 1¼ (nearly), expressing the relation between the elasticity normal to the dodecahedral planes with that normal to the cubic planes. This result is important, as showing that the elasticity in an isometric mineral, like rock-salt, is not throughout uniform, but is dependent upon the direction.

"FLOW" OF METALS.

Professor Thurston, who, nearly simultaneously with Commander L. A. Beardslee, ascertained that an increased power of resisting stress was developed in iron and steel by their subjection to a strain which produced distortion beyond the elastic limit, and gave them a set, has lately presented a paper to the American Society of Civil Engineers, in which he has given the results of extended researches as applied to other metals. He concludes that the simple extension or straining of any member of any metallic structure is not a cause of weakness except where it produces an actual reduction of section resisting rupture, or where it brings the line of stress into a new direction, in which it acts either with a larger component of force in the former direction of stress, or, as in the case of a reflexure of the metal, it takes the material at disadvantage strategetically after a new disposition of its particles has taken place.

The conclusion seems also proper that the elevation of the elastic limit by strain can only occur in metals which are elastic, and are capable of being placed in a condition of reduced resisting power by internal stress, by artificial or external force.

Finally, the conclusion has been arrived at that structures are not weakened by stresses exceeding the elastic power of their members, whatever the material of which they are composed, and even when made of metals having no elasticity, and capable of yielding, like tin, by flow, unless such strains as are produced are productive of actual molecular disruption.—*Letter of R. H. Thurston.*

THE PLASTICITY OF ICE.

Professor Dr. Pfaff has communicated to the Physical Society at Erlangen some experiments upon the plasticity of ice, his experiments being made with the object of obtaining some exact numerical data as to the pressure necessary to change the form of a mass of ice, since it is essentially interesting in the theory of glacial movements to determine the minimum pressure at which the ice is plastic. He finds that even the lightest pressure is sufficient to make one particle of ice slide from another, if it only acts constantly and at a temperature near the melting-point; that, in fact, near the melting-point ice behaves like wax. The results obtained by him com-

pletely explain the fact that the movements of glaciers are more rapid in proportion as the temperature rises; and the theory of glacial movements seems to receive through his experiments a new support. — *Sitzb. Physikal. - Medecin. Gesells., Erlangen*, 1875, 72.

PLASTICO-DYNAMICS.

Within the last few years a new branch of mechanics has been developed by Saint-Venant, known as plastico-dynamics, which occupies itself with the movements in the interior of plastic solid bodies; researches on this subject were made by Tresca, and published in 1864 in a work on the flow of solid bodies, and in a work published nearly at the same time by Saint-Venant on the torsion of prisms of various shapes.

Subsequently, in 1870, Tresca published a work in which he endeavored to explain the phenomena under consideration by tracing out the movements of the molecules of the bodies in question as they moved more or less slowly under the influence of the pressures and resistances to which they were subjected. His principle of the conservation of volumes has been developed by Saint-Venant, who has shown, however, that it is not entirely adequate to explain the observed phenomena, or to give satisfactorily the actual values of the strain in the interior of solid bodies undergoing deformation in consequence of external pressures. Both Tresca and Saint-Venant agree that the fundamental principle of the new science amounts to this, that at every point in the interior of a plastic body which is being deformed the greatest tangential component of the pressure remains equal to a specific constant peculiar to each substance; and from this principle alone Saint-Venant has recently established certain differential equations of the plastic movements, an integration of which would go far toward a complete solution of the problem. Failing in an analytical solution, however, he suggests that experiments must be resorted to, and defines with some precision the nature of the desired observations.—6 *B*, LXXXI., 115.

AN EXPERIMENT IN INSTANTANEOUS CRYSTALLIZATION.

Péligot has recently described in *La Nature* the following interesting experiment: Dissolve one hundred and fifty parts,

by weight, of hyposulphite of soda in fifteen parts of boiling water, and gently pour the same into a tall glass jar so as to half fill it, keeping the solution warm by placing the glass in hot water. Then dissolve one hundred parts, by weight, of the acetate of soda in fifteen parts of hot water, and carefully pour it into the same glass, inclining the latter so that the second solution may gently flow upon the first, and form an overlying layer without mingling with it. When cool there will be two supersaturated solutions. If now a crystal of hyposulphite of soda be attached to a thread and carefully passed into the glass, it will traverse the acetate solution without disturbing it, but on reaching the hyposulphite solution will cause the latter to crystallize instantaneously in large rhomboidal prisms with oblique terminal faces. When the lower solution is completely crystallized, a crystal of the acetate of soda similarly lowered into the upper solution will cause it to crystallize in oblique rhombic prisms. The appearance of the two different kinds of crystals, and the method of their formation by the selection of the disturbing crystal, forms an interesting philosophical experiment. Though not mentioned in our source of information, it would be well to observe the precaution of covering the surface of the upper solution with a thin layer of oil, to protect it against disturbance and the falling in of dust-particles, by which the crystallization will readily be set up, and the foregoing experiment anticipated quite unexpectedly.

FRICTIONAL RESISTANCE OF WATER TO MOTION OF VESSELS.

In the report to the Lords Commissioners of the Admiralty on the experiments for the determination of the frictional resistance of water to moving surfaces under various conditions, it is stated that a number of surfaces were experimented with, the experiments being conducted by drawing known areas of the given body through the fluid. The results may be expressed generally by a formula based upon the assumption that the resistance offered to the particles of fluid is purely dynamic, dependent upon the weights of the particles and the velocities imparted to them. Consequently, for lengths of surface above fifty feet, the increase of the friction per square foot of every additional length is so small that it will make no very great difference in our es-

timate of the total resistance of a surface three hundred feet long, such as the side of a ship, whether we assume such increase to continue at the same rate throughout the last two hundred and fifty feet of the surface, or to cease entirely after fifty feet.—*Proc. Brit. School of Adv. Sci.*, 1874.

THE MOVEMENTS OF WAVES AND VESSELS AT SEA.

The study of the motions of vessels is prosecuted in the French navy with considerable diligence by means of the apparatus invented by Madamet, and described in a note in the *Maritime and Colonial Review*, May, 1876. This apparatus consists essentially of a Foucault regulator causing two pencils to traverse a cylinder with perfect regularity; the whole apparatus being swung on gimbals in such a way that every movement of the vessel is registered, as regards direction, velocity, and time, on a sheet of paper. This apparatus has been used on board of a number of French frigates, such as *L'Océan*, *La Minerve*, and *La Galissonniere*, while lying in the port of Brest, in order to determine completely the movements of vessels oscillating in a calm sea. At present the apparatus is employed in connection with that devised by Risbee, in order to measure the resistance of a vessel to careening.—*Revue Maritime et Coloniale, May*, 1876, 481.

VIBRATION OF FLUID COLUMNS.

The fact that a column of air can be set into longitudinal vibration has suggested to Kundt the possibility of producing similar longitudinal vibrations in columns of water. To this end he sets the tube containing the water in vibration, and finds that the success of his experiment depends principally upon removing from the liquid all traces of gas, whether the latter be absorbed or are in the shape of minute bubbles. The gases absorbed by the liquid are partially driven out by the vibrations, and appear as disturbing bubbles. The so-called tone figures of Kundt can be shown in the vibrating columns of liquid as well as in those of air, and can be used to determine the velocity of sound in the liquid. It is found that the thickness of the glass tube has an influence on the velocity of sound, such that the thicker the tube the more rapid is the propagation of the sound wave.—19 *C*, VIII., 7.

ON THE THEORY OF THE FLOW OF WATER OR GAS.

The important work of Boussinesq, entitled "An Essay on the Theory of Currents of Water," which will be printed by the Academy of Sciences of Paris in the twenty-third volume of its foreign memoirs, has received some interesting additions from its author, among which is one that treats on the transpiration of gases, which interesting subject is known to us at present only through the observations of Grohan, Exner, and others, but whose results are explained by the mechanical theories of Boussinesq. Other additions are those that relate to the uniform regimen of flowing water, and especially, the third addition, that which serves to complete the theory of vertical waves, in which the author calculates the loss of dynamic energy that the waves experience as a consequence of the mutual friction of the layers of liquid as well as the friction against the containing walls. —6 *B*, LXXXI., 466.

HYDRAULIC INVESTIGATIONS IN INDIA.

A very extensive series of experiments by Captain Allen Cunningham on the flow of water in rivers and canals is published as an extra to the professional papers on Indian engineering. After noticing the results derived from Humphrey and Abbott's study of the Mississippi, D'Arcey and Bazeir's studies in France, and Redy's studies on the Paraguay, Uruguay, and La Plata, he states that the primary object in his own investigations has been to test the applicability of the results of the American and French experiments to large bodies of water in regular channels.

Among the conclusions to which his own observations have led him are the unsteadiness in the motion of a large body of water, even in a uniform channel of great length; the velocity at any point varying considerably from one instant to the next, although the average velocity is sensibly constant. The curve representing the surface velocity of a current of water is strikingly regular, and is symmetrical with reference to the mid-channel, while its form depends upon the figure of the cross-section. In a very wide channel it has a flat curve. In a rectangular section in masonry it is approximately a quartic ellipse. The surface velocity near the mar-

gin decreases very rapidly, and at the margin itself is perhaps at zero. In cases of straight margins of great length there is a constant surface motion from the margin toward the centre, most intense at the margin. The average central surface velocity varies on a calm day nearly as the square root of the central depth. The curve representing the mid-channel vertical velocity is approximately a common parabola, whose axis is usually below the surface at a depth depending upon the state of the wind; but the form of the curve is hardly well enough determined to admit of inferring the bottom velocity. The line of maximum velocity is highest at mid-channel, and deeper as we proceed toward the margins.—*Professional Papers on Indian Engineering, October*, 1875.

GAUSS' THEORY OF CAPILLARITY.

Plateau states that, as is well known, Gauss has deduced formulæ relative to particular phenomena of capillarity, by starting from the principle of virtual velocities. The French scientist Moutier has recently shown that the theory of Gauss properly treated explains certain effects attributed of late years to the tension of liquid surfaces, without any necessity of especially assuming the existence of such tension. He has deduced also a general formula concerning the equilibrium of two liquids in contact with each other and with a solid. This formula contains certain constants relative to the different molecular attractions that obtain in the system; and now Van der Mensbrugghe, of Ghent, demonstrates that these constants themselves have a definite physical signification; that they represent, viz., respectively the tension at the free surface of the two liquids, the tension at their common surface, and the tensions at the surfaces of contact between the liquids and the solids.—*Bulletin Acad. Royale des Sciences de Belgique*, 1875, 366.

LIPPMANN'S EXPERIMENTS ON CAPILLARY ATTRACTION AND HIS ELECTRO-CAPILLARY MOTOR.

The facts in relation to capillary attraction, described by Mr. Lippmann, and of which he has availed himself in the contrivance of what he calls the electro-capillary motor, now exciting so much attention in Europe, are not original with him, but are due to Dr. Draper, who discovered them

more than forty years ago, and made them the subject of a memoir inserted in *The Journal of the Franklin Institute* of Philadelphia, January, 1836, and again in *The London and Edinburgh Philosophical Magazine*, March, 1845, in a paper entitled "Is Capillary Attraction an Electrical Phenomenon?" In these memoirs Mr. Lippmann's facts are set forth, and the explanation of them is given. Dr. Draper formerly wrote a good deal on capillary attraction, regarding it simply as an electric phenomenon. His views on the subject are given in detail in the scientific journals above named, and also in *The American Journal of Medical Sciences.*

ON THE ELASTICITY OF GASES.

One of the most extensive experimental researches of modern times is that now being prosecuted by Mendelejeff on the elasticity of gases, the expenses of which are being defrayed by the Imperial Russian Society of Technology, the first of which is now published in the Russian language. Experiments made by Oersted, Rumford, Natterer, and Cailletet lead one to think that under considerable pressures all gases are compressed less than they should be as indicated by Mariotte's law. The greater part of the first volume of Mendelejeff's work is of course occupied with preliminary researches necessary to establish the accuracy of his instruments and methods. The volume concludes with a description of the first experiments made by him upon rarefied gases and upon air compressed under from one to three atmospheres. The results that he has obtained in operating upon air, hydrogen, and carbonic acid, under gradually decreasing pressures, lead to the conclusion that the product of the pressure into the volume diminishes with the pressure; the diminution being especially sensible for air, when the pressure becomes very feeble.—6 *B*, LXXXI., 501.

THE ELASTICITY OF PURIFIED AIR.

Some researches of Mendelejeff and Kirpitschoff show that the product of any volume of air by its pressure, which according to the law of Mariotte should be constant for all pressures, is not so for the air, varying considerably when the pressures diminish to so small a quantity as half a milli-

meter. This product in fact, which for perfect gases is constant, varied rapidly in the case of air. The deviations from the law of Mariotte for rarefied air are contrary to those observed by Regnault for compressed air. In fact, the product increases when the pressure increases, and diminishes when the pressure diminishes. These discordances are far larger than the possible errors of observation.

AIR PUSHED IN FRONT OF A PROJECTILE.

In investigating the various phenomena attending the impact of projectiles, Busch has studied the question as to whether a sphere falling into a fluid drives air before it, or whether the air is simply inclosed by the water as it comes together behind the sphere. The simple apparatus employed by him to study the question consists of a cylindrical vessel full of water in which a plate is hung having in the centre an opening so large that the sphere falling through the water will be caught by it. His experiments show that in the case of bodies falling with a very small living force, the air above the water has time to be completely pushed aside by the falling projectile. But that if the living force of the body is increased slightly to a certain limit, it no longer becomes possible for the air to be entirely pushed aside; but that a certain amount is pushed by the sphere forward, and the quantity of air so driven on increases with the increase in the living force to precisely the degree required by the measurement of Magnus, upon the quantity of air carried with the projectile into the water. If we increase the resistance of the fluid by taking some more viscid fluid than water, such as glycerine or oil, it is found that a greater living force is required in order to carry the air in front of the projectile into the fluid. Even in the case of a shot penetrating a solid body, such as a thin sheet of India rubber stretched over the opening in the plate, a certain quantity of air is driven through in front of the ball.—*Verhandl. Naturhist. Vereins, Bonn*, XXXI., 251.

ON THE PROPULSION OF AIR BY A JET OF AIR OR VAPOR.

An interesting and practically valuable series of experiments has been made by Romilly on certain phenomena, which may be described as the dragging or propulsion of

the atmosphere along with a jet of air or vapor. Any such jet, blown from a fine spout, carries with it a certain quantity of the surrounding air. From an extensive series of accurate measurements made by him, he concludes in general that when the jet is received through a tube into a chamber pierced opposite to the receiving spout by an orifice equal and similar to it, the pressure within the chamber is reduced to one half. Second, that whatever distance the orifice of the spout may be, the effect is always greater if the direction of the jet is the same as that of the axis. In all directions inclined to the axis the effect diminishes very rapidly. The experiments made by him have included the use of conical and cylindrical tubes, and open and closed reservoirs.—6 *B*, LXXX., 189.

EXTENDING THE COMPASS AND INCREASING THE TONE OF STRINGED INSTRUMENTS.

At a recent meeting of the Musical Association of London, Dr. Stone stated that there are three ways in which a string may be made to give very slow vibrations, viz., by increasing its length, its thickness, or its density. He had adopted the third plan by covering a catgut string with heavy copper wire, which proved to be fairly successful. This had been improved upon by re-enforcing the vibrations by means of longitudinal struts or bars, applied to the double bass violin. Four strips of white-wood, curved to an elliptical figure, are passed parallel from end to end, on the inside of the belly of the violin. The result is the removal of what is termed by the musicians "wolf," or inequality and falseness of tone, with a great increase of power throughout the range of the instrument. The same process is equally applicable to small violins, and the bars can be removed at pleasure without damaging the instrument. As an illustration of what may be effected by this system, an instrument whose original cost was 1*s.* 9*d.* was exhibited to which this improvement had been applied, and its performances called forth great applause.—18 *A*, XX., 270.

CONDUCTION OF HEAT BY BUILDING MATERIALS.

The coefficient of conduction for heat of various building materials has lately been carefully investigated by Lang,

who, in his studies, has endeavored to exclude the influence of radiation, and has made measurements by means of the thermo-electric multiplier. He finds that the stones considered by him are much better conductors of heat when wet than when dry, and that various classes of stones, such as marble, sandstone, granite, etc., have approximately the same co-efficients of conduction, while bricks of all kinds are much worse conductors than the natural stones.

CHANGE OF TEXTURE IN SANDSTONE BY HEAT.

According to Mr. John Young, the sandstone bottoms of iron furnaces assume, from the long-continued action of heat, a distinctly columnar form, the old lines of stratification being obliterated, thus showing that heat, as well as electricity and mechanical force, was an agent in the production of the columnar form of rocks.—15 *A*, *November* 20, 676.

ANTIQUITY OF THE BURNING MIRROR.

Buchwalder states, in reference to the burning mirror recently invented by Mouchot, that it was used as long ago as in the days of Numa Pompilius, in whose reign the priests in the temple of Vesta, according to Plutarch, employed a conical reflector, with a solid angle of ninety degrees, as a mirror for concentrating the rays of the sun, thereby producing the heat necessary to light the sacred fires.

OBSERVATIONS UPON RADIOMETERS.

Mr. H. A. Carrington communicates to the *Popular Science Review* a slight contribution in the way of experiments with radiometers, in which he has arrived at the following conclusions: First. That when the radiometer is receiving light or heat, being at a lower temperature than its surroundings, repulsion of the black disks must ensue, and continue until the temperatures are equalized. Second. When the radiometer is radiating heat, being at a higher temperature than its surroundings, attraction of the black disks, or the apparent repulsion of the white disks, must ensue, and continue until the temperatures are again equalized. Third. No source of light can produce repulsion of the black disks unless it is capable of raising the temperature of the residual air within the globe.—*Popular Science Review*, *April*, 1876, 137.

OBSERVATIONS ON THE THEORY OF CROOKES' RADIOMETER.

Professors Dewar and Tait, in the prosecution of their researches into the movements of Crookes' radiometer, have devised methods of producing very perfect exhaustion of air from a receiver; the most perfect vacuum being obtained by taking advantage of the absorbent power of charcoal. The movement of the radiometer, whose disks are of rock-salt, are traced to the unequal heating of the movable parts of the apparatus; and the explanation of the phenomena observed by them is deduced from the kinetic theory of gaseous pressure.—*Proceedings Royal Society of Edinburgh*, VIII., 628.

THE MECHANICAL PRODUCTION OF COLD.

Mr. A. C. Kirk has offered a memoir on the mechanical production of cold to the Royal Institution of Civil Engineers, which attracted extended discussion, and will probably lead to material improvements in many of the mechanical arts. He states that his attention was first drawn to the subject by noticing the inconvenience experienced at certain paraffin-oil works, where it was customary to extract the solid paraffin in winter by exposing the material to a low temperature sufficient to cause the paraffin to crystallize. At those works chemical methods of producing low temperatures had been introduced in order to avoid the otherwise expensive loss of time. These methods were too objectionable to be continued long, and the author was requested, as engineer to the works, to examine the methods invented by Dr. Gorrie, who had constructed a machine that was said to have produced ice in Florida. Mr. Kirk's early experiments with machines similar to those of Dr. Gorrie having been unsatisfactory, attention was turned to an air-engine, the reversal of whose processes it was thought ought to make a good cooling-machine; and, in fact, after many modifications and reconstructions, a degree of cold was produced by it sufficient to freeze mercury. This machine may be in the main described as follows: A steam-engine moves a piston backward and forward, by which the confined air is in a state of alternate compression and expansion. While the air is compressed in one space, the heat generated thereby is

removed by a stream of water flowing through properly arranged pipes; and while the air is expanding and cooling in the other space, heat is abstracted from whatever has been placed in a second properly arranged receptacle. The only limit to the temperature attainable is the conducting power of the material of which the apparatus is composed. The air contained in the pistons may be at any pressure that the apparatus can withstand. The machines built for cooling large masses of water for the use of breweries, etc., are usually worked at from 100 to 120 pounds per square inch, the efficiency and capacity of the machine increasing with increased pressure. To keep up this pressure and meet leakage, a small compressing pump draws air through two boxes containing chloride of calcium. This is necessary to dry the air, for if the air be damp the moisture is deposited as snow in certain parts of the apparatus, and causes mischievous obstructions.

A NEW ICE CALORIMETER.

The ice calorimeter in all its forms measures quantities of heat by determining how much ice that heat can melt. In Bunsen's apparatus advantage is taken of the change of volume which ice undergoes upon fusion. This change occurs at one end of a column of mercury sustained in a capillary tube: as the ice melts the mercury descends, and the amount of fall represents the quantity of heat. But the use of a capillary tube in this apparatus affects the delicacy of all measurements made with it. So Schüller and V. Wartha propose a modification of Bunsen's calorimeter, in which graduated scales are done away with, the amount of mercury involved in any measurement made with the instrument being determined by direct weight. As the ice in the apparatus melts and the column of mercury falls additional mercury flows in through a peculiar suction tube, and the weight thus absorbed affords a measure of the heat. The details of the new calorimeter are not very complicated, but need the author's diagram for their explanation. The inventors tried to apply their instrument to determining the specific heat of some metallic titanium, and obtained a value apparently too high. Seeking the cause of their error, they found that the supposed metal contained nitrogen, being really a compound of the formula TiN_2.—35 *C, September*, 1875.

EXPERIMENTS UPON NON-LUMINOUS FLAMES.

The experiments by Knapp, and the subsequent ones of Blochmann, in which a luminous gas flame was rendered non-luminous by the introduction of gases indifferent to combustion, in place of air, have been modified by Wibel in such a way as to permit the heating of the mixed gases at the moment of combustion. The diluting gas was introduced through a glass tube, soldered into one of the draught-holes of the ordinary Bunsen burner, the others being closed, and the mixed gases were burned from a platinum tube, readily formed by rolling a piece of thin platinum foil spirally, slipped into the top of the burner. Two opposite horizontal Bunsen burners were arranged for heating this tube. Upon heating it when the flame was rendered non-luminous by air, as in the ordinary Bunsen burner, or by carbonic acid, nitrogen, or hydrogen, Wibel noticed the immediate formation of a luminous cone in the interior of the flame, which gradually disappeared when the heating burners were removed. The temperature required was not very high, especially if the gases were mixed in the proper proportions. The flame did not strike down, and in all respects resembled an ordinary luminous flame, affording soot, and also a continuous spectrum. Very slight decomposition took place in the hot tube with nitrogen and carbonic acid, as ascertained by analysis of gas taken from the flame by aspiration, as well as from the exceedingly slight deposit of carbon in the tube. A sheet-iron plate, perforated so as to fit the burner, prevented the products of combustion from the heating burners from coating the flame. It was also found that when the flames of two good Bunsen burners were brought in contact with the exterior mantle of flame, rendered non-luminous by carbonic acid, an interior luminous cone was formed, which disappeared immediately on their removal. He concludes from his experiments that the non-luminous character of the flame in Knapp's experiment is not due to dilution of the burning gas, according to the views of Frankland and of Blochmann, but rather to a cooling of the interior of the flame by the gas introduced—a view that is supported by the peculiarities of the flame when oxygen is the diluting gas. The luminosity of the flame of a substance containing carbon, other things

being equal, depends upon the existence of a temperature in the interior which renders possible the processes of chemical decomposition and combination, from which the luminous body proper results. In ordinary cases the more or less cold gases formed from the illuminating material rushing up from beneath are heated sufficiently by the temperature developed in the exterior zone of combustion to produce the change necessary to luminosity.—35 *C*, IV., 1875, 220.

INFLUENCE OF PRESSURE ON COMBUSTION.

Some interesting observations have been made by Cailletet in burning different substances under pressure. He finds that pressure slightly augments the temperature at which combustion occurs, and that the luminous and actinic rays emitted by the burning body are considerably intensified. When a candle is made the subject of experiment, the base of the flame, ordinarily bluish and transparent, becomes white and very luminous. Soon, however, clouds of smoke are formed, due to incomplete combustion. Under similar circumstances the flame of phosphorus is not sensibly augmented in brilliancy, but sulphur, potassium, alcohol, and carbon disulphide burn much more vividly than in free air. —*Annales de Chimie et de Physique*, *November*, 1875.

THE ABSORPTION OF SOLAR HEAT BY THE ATMOSPHERE.

The discussions of the observations of the black-bulb-in-vacuum thermometer, made in England during the past five years, have led Mr. Stowe to the following conclusions in reference to the influence on solar radiation of the aqueous vapor in the atmosphere. First, when the tension of vapor is small, the radiation is greater than the average. Second, the north and northwest winds, which contain little vapor, show a greater intensity of solar radiation than the south and southeast winds. Third, the hourly changes, due to the varying altitude of the sun above the horizon, are well marked, and allow the approximate determination of the solar radiation as unaffected by the absorption in the atmosphere; this latter varying from a minimum of ten per cent. to a maximum of twenty per cent. A change in the elevation of the station, from 470 up to 1800 feet, diminishes the absorption by five per cent.—7 *C*, II., 57.

THE MATHEMATICAL THEORY OF LIGHT.

An exhaustive memoir on the interference of light, by Professor Lommel, is contained in the Proceedings of the Physical Society of Erlangen, in which he brings the phenomena of thick and thin plates of glass and of curved surfaces into one point of view. Some of the diagrams given by him remind one strongly of those multiplex curves treated of by Professor Newton in the Connecticut Academy of Sciences for 1874.—*Sitzb. Physikal.-Med. Gesells., Erlangen*, 1875, 106.

MATHEMATICAL THEORY OF LIGHT.

The connection between the elliptic polarization of light reflected from mirrors, and the refraction and dispersion of light when passing through transparent media, is developed in a very elaborate manner by Ketteler, who deduces a complete theory from the consideration of the expression $A+B\sqrt{-1}$, which expression Fresnel met with in his investigation of the subject of total reflection. The occurrence of this expression, to which the term "complexe" is given by the French and German mathematicians, is shown by Ketteler to result from the fact that the wave of light reflected from any surface may be considered as a complex wave, consisting of a superposition of two partial waves differing from each other by one quarter of a wave-length. The interpretation which Fresnel himself seems to have given is submitted to a rigid demonstration. Ketteler states that we are led more and more to the conviction that in all dioptrical phenomena we have to do not so much with a special constitution of the optical ether as with the synchronous vibration of the atoms of ether, and those of material bodies; and that, in fact, the ether itself may have the same inertia and density within as without the transparent body. His memoir is especially devoted to the development of the idea that there is a vibration of the ponderable atoms corresponding to the vibrations of the ether.—*Verhandl. Naturhist. Vereins, Bonn*, XXXII., 1 to 224.

DEEP-SEA SOUNDING BY PHOTOGRAPHY.

Dr. Neumayer has presented to the Geographical Society of Berlin a remarkable photographic apparatus for determin-

ing the temperature and the direction-current at any particular depth in the ocean. It consists of a brass box, hermetically closed, and having attached to it an apparatus resembling a vane or rudder. Within this box a thermometer and a magnetic needle are contained, behind each of which is placed sensitive photographic paper, and in front of each of which is a small nitrogen vacuum tube. The box contains also a small induction coil. When the apparatus is lowered to the required depth, the rudder causes it to take a direction parallel to the current there existing, and hence a definite direction with reference to the needle within. The thermometer soon acquires the temperature of the water outside, and becomes stationary. At this instant an electric current is sent to the box, which, by means of the induction coil inside, lights up the little nitrogen tube, the violet light of which, photographically very intense, prints, in about three minutes, the position of the needle and the height of the mercury column upon the prepared paper. The current is then intermitted, the apparatus raised, the photographic tracing fixed, examined, and placed upon record.—3 *B*, *Sept.* 3, 1874, 6.

DISPERSION OF LIGHT BY PRISMS.

Dr. Eugene Block attempts, in his Inaugural Dissertation, to make some additions to the theory of the refraction of light passing through systems of prisms. He says with apparent correctness in his preface that the many occasions on which the spectral analysis is applied in every branch of science has in the last few years brought about important changes in the construction of the apparatus. The greater part of these changes have been prompted, not by theoretical investigations, but by experimental methods, whereby it has happened that many errors have been suffered to remain in the construction of the apparatus which may have a material and deleterious influence upon the sharpness of the spectrum. Dr. Block has therefore made careful investigation and comparison of such instruments as are now in use, and has developed the theory of the refraction of light in systems of prisms. He has extended his investigations to converging and diverging bundles of rays, as also to the influence which imperfect prisms, or the inclinations of the prisms can have upon the purity of the spectrum. Among

the theses defended by him at the close of his inaugural dissertation, we note that the Ketteler formula for dispersion is maintained by him as the most correct that is known; as also that the appearance of the aurora is dependent upon local climatic conditions.—*Block's Inaugural Dissertation*, 1873.

SPECTRUM DISPERSION OF GASES.

Lorenz communicates to the Royal Academy of Copenhagen an experimental and theoretical investigation into the chromatic dispersion of gases. His observations have been made by means of a small spectroscope, and were in part directed toward the constituents of the atmosphere, for which he gives the coefficients of refraction for each of the eight principal lines of the spectrum, and the necessary changes due to the moisture and temperature of the atmosphere. Pure oxygen, nitrogen, hydrogen, the vapor of water, alcohol, ether, chloroform, iodaethyl, carbon-sulphide, and ammonia are successively investigated by him in different degrees of density and temperature.—*Mem. Kongel. Danske Vidensk. Selsk., Copenhagen*, X., 486.

IMPROVEMENT IN SPECTROSCOPES.

Mr. Madan gives a simple method by which we may correct the curvature of the spectrum lines, a defect inherent in all spectroscopes as at present made. This curvature is due to the fact that the rays from different parts of the spectrum fall on the prism under different vertical angles. Mr. Grubb has lately proposed to correct the curvature by a method which had been already employed by Mr. Madan for more than a year past, and which consists in making the slit itself curved instead of straight, the curvature being so arranged as to neutralize the distorting effect of the prism. Mr. Madan's experience shows that the curved slits give perfectly satisfactory results, and that they may be easily adapted to any spectroscope; so that by having several such slits in succession, we may secure straight lines in the field of view for varying powers of dispersion. He finds that slits whose edges are curved to a radius of 21 centimeters, sensibly correct the distortion of a single carbon bisulphide prism, the

reflecting angle of which is 60 degrees. A slit whose radius is 10 centimeters corrects the distortion of a train of two such prisms.

SPECTRUM APPARATUS FOR THE NEW OBSERVATORY AT POTSDAM.

The maker of the optical apparatus for the Bothkamp Observatory has lately finished the spectrum apparatus for the new observatory at Potsdam, which probably is the most complete instrument of its kind. The maker, H. Schroeder, says of it that the apparatus consists of 21 single prisms combined into a system according to Rutherford's method, they being moved automatically and in such a way that the motion is accomplished with mathematical accuracy and with the greatest ease. This automatic movement allows of exact differential measurements with hitherto unattained accuracy, and is the first apparatus of this kind that has been constructed as an exact instrument for measuring. According to Dr. Vogel, the measurements are perfectly trustworthy to the one-hundredth part of the interval between the double line D of sodium, the optical performance of this spectroscope being such that the sodium line is separated into nine fine lines. Almost all the principal lines of the spectrum are resolved into groups of lines, while new lines are seen among those hitherto known.—7 *C*, XI., 55.

THE ATMOSPHERIC LINES OF THE SOLAR SPECTRUM.

J. B. N. Hennessey, of the Trigonometrical Survey of India, communicates to the Royal Society of London a short memoir on the atmospheric lines of the solar spectrum as observed by him on the point known as Vincent's Hill, among the Himalaya Mountains, in the northwest province of India, at an altitude above the sea of 1700 feet. His observations were made not only with an old spectroscope, as used in 1868 to 1871, but with a newer and finer instrument supplied by the Royal Society in 1872; and he publishes a map of the solar spectrum, showing the atmospheric lines as observed with the latter instrument. A comparison of the solar spectrum, as seen when the sun was within two hours of the meridian and as seen at sunset, shows the very striking changes introduced by atmospheric absorption. Thus

near the Fraunhofer lines A and B intense black lines are introduced, while others having but slightly less intensity occur near 48, 71, 81, 99, 101, and 183. Especially remarkable is the great increase of bands in the more refrangible portion of the spectrum; thus from 26 to 40, faint bands, and from 46 to 60, from 68 to 74, from 95 to 102, and 107 to 116, very decided bands appear at sunset, which are not visible at midday. Mr. Hennessey has observed sunsets to the number of about 100 since 1870, and has also noticed that during the autumn a kind of haze springs up in the horizon, growing higher and higher from day to day, and denser, forming a permanent winter bank of haze; by carefully observing the effect of this bank of haze on the solar spectrum, he has found beyond all question that as this bank rises day by day higher and higher, the corresponding sunset spectrum bands successively disappear, showing that the lines which are visible when the sun sets in the true horizon are introduced into the spectrum by reason of the greater thickness of the stratum of air traversed by the sunlight. He states that certain lines, for instance, number 813, are almost as good as a clock. This line commences to change as early as two or three o'clock P.M., and becomes an intense black stripe at the horizon. He states his conviction, also, that besides other changes in the solar light as the sun approaches the horizon, there is this peculiarity—that the rays of less refrangibility actually become visible, so that the spectrum appears to be extended toward the right hand.—*Phil. Trans. Royal Soc. of London*, 1875, 157.

OPTICAL NOTES BY MR. LEA.

M. Carey Lea, of Philadelphia, states that having a year ago published a train of investigations into the sensitiveness of certain substances to particular rays of light, leading to results incompatible with the late announcement by Dr. Vogel in reference to the sensitiveness of silver bromide when washed with color varnish, he has since then continued his investigations, and while on the one hand Dr. Vogel has adopted his own views, he himself on the other hand has been led to the positive conclusion that there exists no relation whatever between the color of the substances and the color of the ray to whose influence they modify the sensitiveness of the silver bromide.

METHOD OF ESTIMATING COLOR IN WATER.

Mr. King, city analyst of Edinburgh, has published in the *Chemical News* a method of estimating color in water for the purpose of determining the comparative turbidity of different samples. This method consists in adding to a known quantity of pure distilled water contained in a glass tube an aqueous solution of caramel of a certain strength until the tint communicated to the distilled water is found to equal that of the water under examination. The tubes he employs are made of perfectly colorless glass, fifteen inches long, and of such a diameter that when filled to within three inches of the top they will contain exactly eight ounces of water. The depth of color which the distilled water and caramel should exhibit is ascertained by adding ten grains, by volume, of solution of ammonium chloride to eight ounces of pure water, perfectly free from ammonia, in a glass tube, forming a column twelve inches long. The ammonium chloride solution should contain 3.17 grains of the salt in 10,000 grains of water. To this mixture, after proper agitation, 25 grains, by volume, of Nessler's solution are to be added; and this, after mixing, is allowed to repose for ten minutes at a temperature of 60° Fahr., when the color will form 30° of Mr. King's scale; or, in other words, 300 grains, by volume, or 30° (a degree being equal to ten grains by volume) of caramel solution, if of proper strength, will produce exactly the same depth of color when added to the same amount of distilled water (eight ounces) in a column twelve inches long. The caramel solution being thus prepared, in order to estimate the color two tubes of the dimensions stated are to be filled to within about three inches of the top, one with distilled water and the other with water to be tested. The caramel solution is then to be added to the distilled water until that is found to equal in color the water contained in the other tube. Every 10° consumed will represent 1° of color. The intensity of the color is ascertained by looking down through the length of the column.—1 *A, March* 25, 1875, 133.

FLUORESCENCE OF SOLUTIONS IN CASTOR-OIL.

Some coloring matter derived from woods that do not show any fluorescence when dissolved in water, alcohol, or other

solvents, are stated by Charles Horner to exhibit this phenomenon when dissolved in castor-oil; and other substances which he dissolved in alcohol show this property with augmented intensity when treated with castor-oil. To obtain clear solutions, the materials are first boiled, then filtered, evaporated to dryness, and again dissolved in oil under the influence of heat. The fluorescence disappears when hot, but returns on cooling. A number of facts are given by him showing the increased intensity of the fluorescence of these solutions, and suggesting the importance of taking advantage of this property in studying the phenomena; in fact, it seems that fluorescence is a property of solutions rather than of simple substances.—7 *A*, XLVIII, 165.

THEORIES OF MAGNETISM AND LIGHT.

Boltzmann has experimentally confirmed the theory that light and electricity are only different forms of motion of one and the same medium, by showing that from it there should result a certain relation between the refractive power of a substance and its dielectric properties, a relation confirmed by observation. A further confirmation of the same theory has also been lately published by Boltzmann, based on investigations into the behavior of non-conducting bodies under the influence of electric forces. He says that, according to Maxwell's theory, the constant of dielectricity for non-isotropic crystallized bodies must depend upon the direction in which the electric forces act upon it, varying in a manner such as can be predicated from the optical properties of the body. The only double refracting crystals that are appropriate to the investigation are those of sulphur. Two spheres cut from crystals of sulphur, whose optical axes had been previously determined, were experimented with by allowing the electricity to act in various directions in reference to the optical axes. In this manner the magnetic axes, as they may be called, were determined, and were shown to agree with the optical axes; and the same results being arrived at from both spheres, he concludes that these observations not only confirm Maxwell's theory as to the nature of electricity, but also definitively decide that the vibrations of ether forming light are perpendicular to the plane of polarization.—19 *C*, VIII, 105.

THE INFLUENCE OF ARMATURES UPON MAGNETS.

Jamin, by very careful observation, has shown that the placing of an armature on the end of a magnet brings about a new distribution of the magnetic forces, but that the total force is neither increased nor diminished; the magnet itself loses, but the armature gains magnetic force.—19 *C*, VIII., 104.

FORMATION OF NATURAL MAGNETS.

Dr. Schönfeldt, of Dorpat, Russia, gives, in the Bulletin of the Naturalists' Society of Moscow, an exhaustive treatise, historical and otherwise, on the magnetic forces discoverable in various kinds of matter. After giving numerous historical references, culled from the archives of China, Phœnicia, Greece, Egypt, India, and elsewhere, and a very complete account of the research of modern physicists, he proceeds to give the results of the experiments made by himself. His first aim seems to have been to produce artificial magnets by methods as nearly as possible in imitation of what might be supposed to have been the processes that have obtained in nature. He states that he filled a glass tube five inches long and three fourths of an inch in diameter with pure iron filings, after he had wet them with a thin solution of lime. The ends of the tube were closed with glass stoppers. After the contents had been exposed to a slight warmth for two days, thereby becoming thoroughly dried, it was closely wrapped around with insulated copper wire through which a pretty strong current of electricity was allowed to pass. In ten minutes, during which time the tube had become slightly warm through the influence of the electric current, it was removed from the spiral and cooled. For days and days after that, whenever the tube was suspended by a thread, it was found to be as magnetic as a strong magnet. A considerable time after the tube was carefully broken and separated from its contents, whereby there was obtained a solid, pretty light, very active magnetic cylinder, in which the iron filings had been in great part converted into oxide of iron. Another cylinder, prepared in the same way and broken into very small pieces, showed a similar magnetic polarity, which it even now preserves after a lapse of twenty-

five years.—*Bulletin Soc. Imp. des Naturalistes, Moscow*, 1874, 310.

THE DISTRIBUTION OF MAGNETISM IN A MAGNET.

The investigations by Jamin on the distribution of magnetism in solid and compound magnets have already been fully noticed by us; the latest paper on this subject is by Professor Rowland, of the John Hopkins University at Baltimore, who states that some investigations of his own made in 1870 and 1871, and which have not been published as yet owing to reasons beyond his control, bear directly upon the points investigated by Jamin and others, and he has therefore begun the publication of them in full. He begins by giving the mathematical theory of the distribution of magnetism. His formula may be considered, he says, simply as the development of Faraday's idea of the analogy between the magnet and the voltaic battery immersed in water, and are similar to those of Jamin and Green, but have the advantage of being obtained in a more simple manner than Green's, and, what is of more consequence, all the limitations are made at once, after which the solution is exact; so that, although they are only approximate, yet we know just where they should differ from experiment.

One of the most novel features of the observational part of Professor Rowland's work consists in the method itself, by means of which he measures the intensity of the magnetism at any portion of the magnet. This consists in sliding a small coil of wire which just fits the bar, and is also very narrow, along the bar, inch by inch, and noting the induced current by the deflection of the galvanometer needle. —*American Journal of Science and Arts*, X., 325.

ON THE DISTRIBUTION OF MAGNETISM IN SHORT THICK MAGNETS.

A second series of investigations has been made by Jamin in reference to the distribution of magnetism in compound magnets having a finite length. The formula for this case can be deduced theoretically from those of his previous papers, as applicable to bars of infinite length; and having taken this step, it remained only for him to verify this law by actual experiments. This he has done by employing, as

before, bundles composed of from one to twenty thin steel plates, the dimension of each plate being the same as before. The agreement of the formulas with the observations has been perfectly satisfactory; and, as he remarks, "we are now enabled to construct to order a magnet containing any given quantity of magnetism, or affording at its extremity any desired intensity." We can also calculate the position of the poles and the magnetic moment of such a magnet, and can determine the maximum limit of its magnetism. There remains, however, still to be examined the question of the variation of magnetic power with temperature, and with the chemical or physical structure of the metal.—6 *B*, LXXXI.

ON MAGNETS COMPOSED OF COMPRESSED POWDER.

In connection with his researches on magnetism, Jamin states that he has repeated some interesting observations published in 1836 by De Haldat. He has, viz., by compressing strongly, by means of a small hydraulic press, some iron filings in a tube, found that when they commenced to solidify the polarity increased considerably, and continued increasing with the pressure. In order to be sure of the nature of the original powder, he prepared some from pure soft iron which had no appreciable magnetic force, but the resulting phenomena were as before. We have, then, the case of a metal which has no coercitive force when it is continuous, but which acquires such, and that to a great degree, when it is reduced into discontinuous small fragments, and when these are joined by pressure. Is it not, then, to this discontinuity that it is necessary to attribute the observed polarity, and does not this experiment explain the magnetic force of steel? The question thus put reminds one of Jamin's previous experiments, which have shown that the distribution of magnetism within a magnet can only be explained by considering the latter as composed of very small filamentary magnetic elements having opposite poles, and acting upon each other. The present pressure experiments seem to show that these filaments may possibly be identical with the small fragments of iron filings, or with the small crystals agglomerated together in the case of steel. A further investigation of this subject, by means of a very

powerful and accurate hydraulic press, is promised by the distinguished author.—6 *B*, LXXXI., 205.

ON THE DISTRIBUTION OF MAGNETISM IN BUNDLES OF INFINITELY LONG, VERY THIN PLATES OF IRON.

M. Jamin states that, having investigated the distribution of magnetism in infinitely long thin plates of iron, and found it represented by an exponential formula whose constants depend respectively upon the nature and the temperature of the iron or steel, he has now continued his researches by combining any number whatever of such plates, but still considering the case when the bundle is infinitely long with reference to its other dimensions. The first result of this study was to show that a saturated magnet is a bundle of elementary magnetic threads inclosed within their average section as by a band, but expanded toward their extremities. The number of these bundles depends only upon the mean section, provided that their polar surfaces are sufficiently expanded. The total quantity of magnetism in the thin plates is equal to the product of its section by a constant factor, which factor is independent of the length, and is proportional to the thickness of the plate, and also to its breadth. These three laws can be easily demonstrated by determining the magnetic force of plates of variable length, breadth, and thickness. By means of a number of bars having a length of ten inches and a breadth of less than one inch, Jamin formed a compound magnet whose dimensions were alterable at pleasure; this has enabled him to test his laws under a very wide range of circumstances, and it was demonstrated thereby that by superposing these plates to any number whatever, and in any direction whatever, the resulting bundle always contains the algebraic sum of the magnetism of the various elements. This, however, is only true when the bundle is so proportioned that its length may be considered as infinite. By combining fifty such plates, as nearly identical as possible, in different manners, he has very successfully investigated the law of distribution of the total magnetism; and finds that it can be exactly represented by an exponential formula similar to that which he has already shown to obtain in reference to simple plates, and which therefore enables one, knowing certain constants which may

easily be determined, to calculate the magnetism at any point of any magnet whatever.—6 *B*, LXXXI., 11, 177.

MAGNETIC OBSERVATIONS IN THE INDIAN OCEAN.

It is noted that the magnetic observations made at twelve stations occupied by transit of Venus parties are all due to the observers trained at Stonyhurst. At each of these stations, for about five months, observations were made every two hours during the day and night; and these will, it is hoped, afford a fair knowledge of the spring and summer weather in the Pacific and Indian Oceans.—*Quart. Jour. British Met. Soc.*, 1876, 81-87.

MAGNETIC MAP OF FRANCE.

The *Annuaire* of the Bureau of Longitudes for 1876 contains a magnetic map of France, prepared by Marié Davy. It is the intention hereafter to annually publish this same map with such corrections as it needs from time to time. It would be very highly appreciated in America, if our own Nautical Almanac Office would add a similar work, showing the distribution of terrestrial magnetism in the United States, to its present publication, which, while principally astronomical, contains something having reference to the tides and to terrestrial physics.—*Annuaire Bureau of Longitudes*, 1876, 326.

ON THE DEVIATION OF THE COMPASS.

Belavenetz, as the Director of the Compass Observatory of Cronstadt, has invented an apparatus for annuling the influence upon the ship's compass of the permanent and induced magnetism of the ship. The application of this apparatus has therefore the result of forcing the ship's compass to indicate always the true meridian, no matter in what direction the ship may head. The arrangement of the device by Belavenetz, in fact, completely eliminates the semicircular and the quadrantal deviations, so that, by means of horizontal and vertical magnets and powerful iron cylinders, the deviation on board of a ship, the inclination, and the total magnetic force are brought back to their normal values for the portion of the earth in which the ship happens to be.—*Austrian Hydrog. Mitth.*

DEVIATION OF THE COMPASS IN IRON SHIPS.

It is now tolerably well ascertained that some of the sudden and heretofore unaccountable variations in the deviation of the compass needle on board of iron ships are caused by the unequal and varying diffusion of heat over the iron hull. It is affirmed that to unsuspected changes in the indications of the needle, arising from the cause above named, frequent errors in reckoning, and perhaps shipwreck, may be justly ascribed. Sudden changes, amounting to as much as five degrees, have occasionally been noticed on vessels of this kind on the American coasts, which can only be reasonably explained upon the foregoing supposition. In the instances alluded to the variations were attributed to changes in the hull, caused by the passage of the vessel from cold to warm water, or the reverse, as, for example, into and out of the Gulf Stream; or to the effect of the sun's heating influence being unequally distributed, striking on one side only, and perhaps subsequently changing to the other.—20 *D*, *Oct.* 7, 1875, 15.

NEW RELATION BETWEEN ELECTRICITY AND LIGHT.

A new relation between electricity and light has been announced by Dr. Kerr, of Glasgow, who finds that when glass, which in its normal condition is a singly refracting medium, is properly subjected to the action of electrostatic force, it assumes a new molecular structure, and thus acquires the property of double refraction. A Ruhmkorff's induction apparatus was employed, and a block of plate-glass served as the dielectric medium, while polarized light was transmitted through the glass in a direction perpendicular to the lines of electric force. Under these conditions the glass acts as though it has suffered compression along the lines of force, or, in other words, it becomes a negative uniaxial medium. Similar results were obtained with other dielectrics, the action of resin, however, being contrary to that of glass, or positive.—15 *A*, *November* 20, 676.

ELECTRICITY FROM DIPPING METALS IN FLUIDS.

If two similar pieces of metal are simultaneously immersed in a fluid, they give no electric current; but if dipped successively, an electric current is observed, as has been long

known. In fact, the electro-motive force, at the separating surface of the metal and the fluid, varies according to the time that they have been in contact with each other. This variation of the electro-motive force is, in many cases, purely a secondary phenomenon, in that by chemical means a foreign substance is formed between the metal and the fluid, which greatly changes the separating surface, and gives rise to a chemical polarization. Electric currents are also, in these cases, due to the accidental formation of foreign substances, and to the exposure of the metal to the atmosphere, or to contact with the fingers. But even when foreign substances and chemical influences are excluded in the most perfect manner possible, as, for example, when platinum or gold, is dipped in water, movements of the needle are still visible; and it has been suspected that the air which is retained in contact with the surface of the metal, or perhaps the method that has been employed to cleanse the platinum or gold may have had an important influence in bringing about an electric current. Quincke has recently subjected this phenomenon to careful investigation, and has observed that the strength of the electric current increases with the increasing resistance of the column of fluid between the electrodes; that it increases with the decreasing strength of the concentration of the salt solution that may be employed; that it has no relation to the capillary constants of the fluids employed, and that it originates probably in the change in the molecular condition of those portions of the fluids which are in the neighborhood of the metallic surfaces.—19 *C*, VIII., 71.

PRIORITY OF DISCOVERY OF THE PRINCIPLE OF THE GRAMME MACHINE.

According to a recent lecture of Dr. Andrews, the celebrated magneto-electric machine of Gramme, which is the only one that gives a continuous electric current, was preceded by the publication in 1865, by Dr. Pacinotti, of Florence, of a machine for a similar purpose, whose essential feature was in the novel form of the armature, by means of which continuous electrical currents, always in the same direction, could be obtained from a magnet. Pacinotti does not indeed appear to have constructed the machine described by himself, but states that he verified the correctness of his views, and

satisfied himself that a magneto-electric machine could be constructed which would give induced currents, all in the same direction. The ring armature employed by him was not essentially different from that invented by Gramme, although, according to Professor Andrews, through a serious blunder in the construction of his machine, Pacinotti could not possibly have attained M. Gramme's results.

THE GRAMME ELECTRIC MACHINE.

The Gramme magneto-electric machine has for some time been employed for supplying light at the Houses of Parliament in London, and an idea of its power may be gathered from the fact that it is worked by a steam-engine at a distance of 480 feet from the point at which the light is produced, the current being conducted thither by copper wires one sixth of an inch in diameter. The magnets in the machine are arranged upon three massive rectangular blocks, and make 389 revolutions per minute, at an expense of $2\frac{3}{4}$ horse-power, and give a light equal to over 3000 of the English standard candles.

A NEW THEORY OF GALVANIC RESISTANCE.

According to Herwig, the resistance to a galvanic current offered by any metallic conductor is a subject that has as yet been but little understood. The phenomena themselves consist principally in the following: (1) The nearly uniform rate at which the resistance increases with the temperature; (2) metals in a liquid condition have a greater resistance than as solids at the same temperature; (3) for liquid metals the resistance increases with the temperature, but to a much less degree than for solids; (4) the transition from solid to fluid, as well as that from fluid to vaporous condition, is accompanied with an increase of resistance; (5) in the case of saturated metallic vapors a diminution of the resistance is produced by an elevation of temperature; (6) a greater resistance is found at the boundary surface between fluid and solid portions of the same metal than within the vaporous atmosphere itself.—19 *C*, VIII., 71.

ON THE INFLUENCE OF LIGHT UPON THE CONDUCTIVITY OF CRYSTALLINE SELENIUM.

Dr. Werner Siemens writes that he has investigated the conductivity of selenium as affected by light. He states that although the selenium has an extraordinarily irregular absorptive power, and although consequently the increase in its conductivity by the action of light is very variable, yet by soldering two pieces of flat spiral wire at a distance of one millimeter from each other between two pieces of mica, he was able to construct an extremely delicate measure of light. Dark heat rays have no direct influence in this arrangement upon the conductivity; warming the selenium diminishes the conductivity. Diffuse daylight doubles the conducting power, but direct sunlight increases this power tenfold; and he states that he hopes to be able, by means of this mineral, to construct a reliable photometer.—*Monatsb. k. Akad. der Wissens., Berlin*, 1875, 280.

CONDUCTION OF ELECTRICITY BY COMPOUNDS OF SULPHUR.

According to the observations of Herwig, the resistance which iron and steel offer to the passage of the galvanic current varies with the direction, intensity, and duration of the current itself. Similar phenomena have now been made known from the observations of Braun in reference to a large number of both natural and artificial compounds of sulphur; the effects in question amount to thirty per cent. of their entire value, so that of the existence of these differences there can be no question. A connection between the crystallographic peculiarities of the minerals and the direction of maximum or minimum galvanic resistance is not clearly made out, although indicated in some cases.—19 *C*, VIII., 95.

ON THE GLOW DUE TO GALVANIC CURRENTS.

The experiments made by Müller in Freiburg a few years ago gave the first correct information with respect to the law which regulates the glowing of wires through which a current of galvanism is passing. Müller's experiments and methods have been the subject of a communication to the Bohemian Academy of Sciences by Professor Von Waltenhofen, who states that Müller's results seem to accord less ac-

curately with theoretical considerations than the results of Zöllner's investigations of the same point. The principal results of Müller's observations were expressed by him in formulæ or curves which showed that for a given length of wire of a given thickness and for a given strength of battery there exists a maximum intensity of the glow; and, again, if the wire of given length must be made to glow, the thickness of the wire must lie between two well-defined limits.

Von Waltenhofen shows, in addition to this, that, at least for the more intense stages of glow, we are always justified in considering the specific resistance of the glowing wire as nearly constant.—*Sitzb. k. Akad. der Wissens.*, 1874, 79.

CURIOUS ELECTRICAL LIGHT.

Dr. James Blake states that on the evening of the 30th of September, 1874, at Placerville, El Dorado County, California, while watching the lightning continuously flashing in the southwest horizon, he observed, at a quarter past seven, a luminous appearance apparently proceeding from the crest of the range of mountains about six miles distant to the southwest, which was visible through an arc horizontally of about 15°, and extended about 8° above the horizon. The light lasted for about a quarter of an hour, was undoubtedly electrical, appeared like a fine display of the aurora, and may have been due to the silent escape of electricity from the crest of the ridge. The storm in question was the greatest electrical disturbance recorded since the settlement of the country.—*Proceed. Cal. Acad. of Science*, V., 406.

PHENOMENA ATTENDING ELECTRIC DISCHARGES.

Schneebeli, in a short note on the electric discharge, accompanied with diagrams showing the zigzag and other peculiarities of the discharge, states that the method which he pursues for fixing these figures consists in employing a paper wet upon one side with a solution of gum lac in alcohol, which permeates the paper, and fixes without changing its outlines the blackened trace on the other side of the paper formed by the electric discharge itself. That part of the figure made by the discharge which is near the positive pole is traversed by very fine lines, and the isolated branches shoot from the main stem in all directions. That part of the figure of the

discharge formed at the negative pole shows these fine lines only in the immediate neighborhood of the pole, and has no isolated branches. It will be remembered that the figures called Lichtenberg figures show also a very remarkable difference between the two electricities. The most instructive peculiarity of Schneebeli's figures is found in a very well-marked point near the centre of the figure, and separating the positive from the negative discharge. This central point has every appearance of being that in which the layers of air meet, after moving in opposite directions from either pole toward the centre. When very strong electric discharges are employed, this peculiar meeting-point is obscured, but becomes very distinctly marked when feebler discharges are made.—*Bulletin Soc. des Sciences Naturelles, Neuchatel, May*, 1875.

DUPLEX TELEGRAPHY.

In some historical notes on the development of duplex telegraphy, Mr. Cracknell, the superintendent of electric telegraphs in New South Wales, states that this art, which consists essentially in working in two opposite directions on one wire simultaneously, was first tried as far back as in 1853, by Dr. Gintel, the director-general of telegraphs in Austria, on the line from Vienna to Prague. In his arrangement the compensating currents of electricity could not well be controlled, and the system was not found to be a practical success, although experimentally it worked beautifully. In 1854 Frecher, Siemens, and Halske devised a modification of the duplex method by adopting a somewhat complicated system of resistance coils. These were the first Morse instruments used on telegraph lines in New South Wales, in January, 1858. They could not be made to work satisfactorily, and were reduced to single-acting Miller's recorders. Siemens and Halske's arrangement was worked on what is called the differential principle. Stearns' duplex system, lately perfected in America, and now attracting the attention of telegraph engineers in most parts of the world, is on a principle which is dependent on producing an equality of tensions, which are sometimes called potentials. With this system the relay coils are wound with double wires. It has proved a great success, partly by improvements on old principles, but more particularly in consequence of the intro-

duction of more perfect appliances, since Gintel's and Siemens and Halske's inventions.—*Transactions Roy. Soc. of New South Wales*, 1874, 71.

THE DOUBLE-BALANCE METHOD IN DUPLEX TELEGRAPHY.

Louis Schwendler, electrician in charge of the telegraph lines of India, has communicated to the Asiatic Society of Bengal a memoir on the general theory of duplex telegraphy, and has investigated with great detail the conditions necessary to the successful use of the bridge method under two suppositions: first, that the line is in perfect insulation, and, second, that the line has appreciable leakage; the latter being of course the actual case in practice. He first shows that, in order to obtain the best results in both cases, the resistances and the currents must have certain relations to each other, such that there should be two balances, viz., a balance in one branch for the receiving current, and a balance in another branch for the outgoing current. This method elaborated by him, and which he calls the double-balance method, fulfills the following conditions, which he states are necessary, and are sufficient to place duplex telegraphy on a par with single telegraphy. First, any variation in the resistance of the line has the least possible disturbing effect on the receiving instrument. Secondly, any disturbance can be eliminated by a single adjustment without disturbing the balance in a distant station. Thirdly, the maximum magnetic moment of the receiving instrument is obtained and employed. Fourthly, a maximum working current is available. This double-balance method was introduced by him first in June, 1874, between Bombay and Calcutta, and has since then been working so satisfactorily even during the worst time of the year, viz., the southwest monsoon, that Colonel Robinson, director-general of the telegraphs in India, has decided to introduce this duplex method also on the other long main lines of India.—*Journal Asiatic Society of Bengal*, 1874, 218.

SCHWENDLER'S METHOD IN DUPLEX TELEGRAPHY.

In the annual address of the President of the Asiatic Society of Bengal, it is said that the double-balance method in duplex telegraphy, as invented and perfected by Mr. Schwend-

ler, of Calcutta, was introduced, on the 28th of January, 1875, on one of the main lines from Calcutta to Bombay, 1600 miles; since which time, and in the worst season—the southwest monsoon—the method has worked with great regularity and speed. In a few days another main line from Bombay to Madras will be worked; and it is probable that before the lapse of the current year (1875) the whole of the main traffic in India, from Calcutta to Rangoon included, will be carried on by this system. The method is also practicable on cables, as shown by the experiments with the cable from Bombay to Aden, 1800 miles long. It has been mathematically demonstrated and confirmed by practice that Schwendler's double-balance method involves all the necessary conditions to bring duplex telegraphy on a par with single telegraphy.—*Proceedings Asiatic Society of Bengal, Feb.*, 1875.

NEW ELECTRIC APPARATUS FOR RAILROADS.

Preece's single-wire block signaling instruments are in extensive use in England. They possess one special and important advantage which no other single-wire system has: that the consentaneous action of the two signal-men at the station in advance and in the rear is necessary in order to lower the semaphore to the point which indicates "all clear," thus avoiding the production of a false safety signal from any accidental current. A part of the same apparatus consists in the single repeater which repeats back electrically the movements of a signal which may be out of sight of the man who works it.—*Forty-second Ann. Rep. of the Royal Cornwall Polytechnic Society*, 80.

EAST INDIAN TELEGRAPHY.

The reports from the Indo-European Telegraph Company say that the average time in transit between London and India, *via* Teheran, of all outward messages to India, including the messages for Penang, Singapore, China, Japan, Java, and Australia, for the week ending October 8th, was one hour and sixteen minutes.—*Engineer*, XL., No. 1034, 281.

ATMOSPHERIC ELECTRICITY.

Professor Van der Mensbrugghe, in a memoir on the application of thermo-dynamics to the study of the variations

of the potential of liquid surfaces, is led to a conclusion of capital importance to meteorology. His equations, namely, seem to prove rigorously that any change in the surface of the liquid gives rise to a change of temperature, and, if the circuit is closed, to a thermo-electric current. His experiments show that, on the one hand, the water of the ocean under the action of the sun, being submitted to a continual evaporation, must affect the calorific and the electric state of the earth, and develop constant thermo-electric currents. On the other hand, the enormous quantity of vapor which is lifted into the atmosphere is there subjected to incessant variations in respect to the surfaces of contact with the air of its vesicles, raindrops, etc. Its reduction from a state of extreme and almost molecular tenuity to a state where, by sudden condensation it forms larger raindrops, enables it to actually produce enormous quantities of electricity, until the drops fall in turn upon the surface of the globe from which they were elevated. Thus we have at once, on the one hand, the existence of a constant source of thermo-electricity circulating around the earth, and on the other hand a permanent cause of atmospheric electricity. — *Bulletin Acad. Royal des Sciences de Belgique, Bruxelles*, 1876, 782.

LIGHTNING FROM A CLEAR SKY.

The rare phenomenon of a stroke of lightning from a clear sky was observed on the 3d of July, at 4 P.M., at Senftenburg, Saxony. At that time a thunder-storm was observed so far distant that some thirteen to fifteen seconds elapsed between the flashes and the thunder, when suddenly in the clear sky, in the immediate neighborhood of the observer, Dr. Roch, a blinding flash and fearful thunder occurred. Especially noteworthy was it that this abnormal flash put an end to all the distant lightning and thunder; and the storm clouds very quickly disappeared from the heavens, which retained during the night their original purity.—*Sitzb. Naturw. Gesells. "Isis," Dresden, December*, 1875, 118.

PROTECTION AGAINST LIGHTNING STROKES.

In his annual address as President of the Meteorological Society, Dr. R. J. Mann states that Professor Melsens, of Brussels, has been for some time engaged in an interesting

series of experiments as to the capacity of copper and iron to transmit electric force. He states that Melsens demonstrates that an electric discharge does not of necessity pursue the shortest and easiest path. As to the density of copper and iron when subjected to the disintegrating dispersion of electrical discharges of high tension, he states that under the same circumstances the copper wire used as a conductor for a charge from fifteen very large Leyden jars is completely dissipated into a trail of black dust, while the iron wire is not even broken under the same circumstances, but is simply beaded along its entire length by a series of successive protuberances. Professor Melsens has adapted a very elaborate system of about 428 points belonging to as many iron rods to the protection of the Hôtel de Ville at Brussels from lightning. The rods are collected ultimately into a group of eighteen larger stems, which are soldered into a continuous metallic mass, from which they ultimately diverge underground to the water-pipes, gas-pipes, and moist ground; securing a triple earth contact which would seem to present perfect assurance against danger. Melsens entertains the magnificent design of protecting the entire town of Brussels in one continuous system of rods, so that by securing a very ample development of earth contacts beneath, and air terminals above, no possible danger can be apprehended for the whole surface of the town.—*Quarterly Journal British Meteorological Society*, 1876, 48.

LIGHTNING-CONDUCTORS.

Dr. R. J. Mann states that the following conditions are indispensable for protection against lightning: first, ample dimension and unbroken continuity in the lightning-rod; second, free earth contacts, with frequent examination by galvanometers of the condition of these to prove that there is no gradual impairment through the operation of chemical erosion; third, the employment of points enough to dominate all parts of the building; fourth, the addition of terminal points to the conducting system wherever any part of the structure of the building comes near to the limiting surface of a conical space, having the main point of the conductor for its height, and a breadth equal to twice the height of that point from the earth for the diameter of its base; fifth, the

avoidance of all less elevated conducting divergences within striking distance of the conductor, and especially such dangerous divergences of this character as gas-pipes connecting with the general gas-main, and therefore forming good earth contacts.—12 *A*, XII., 80.

SURFACE TENSION OF LIQUIDS.

Cintolesi has experimented on the relation which the surface tensions of various liquids sustain to each other under various conditions. Of these conditions, temperature is one of the most important. A drop of olive, almond, or castor oil placed upon distilled water at 100° retains its lenticular form, and does not spread into a film. At 65° the drop begins to flatten, and at 50° the film forms, but is silver white, showing no color. If, however, water at 100° be allowed to fall on a surface of cold oil, a membrane is formed, which at first shows colored rings, but which soon contracts into a drop as it cools. Examining solutions of various salts in the cold, he observed the well-known wide differences of behavior with different oils. Repeating the experiments at 40°, he found that even so slight an elevation of temperature completely reversed the phenomena in many cases, making the surface tension of the solution less than that of the oil. He used alcohol, ether, and benzene, copaiba balsam, the fixed oils of olive, castor, almond, and linseed, and the ethereal oils of cinnamon, clove, mint, lavender, and bitter almonds. With cinnamon and clove oils there was at first a spreading out into a film; then the film was ruptured, forming numerous flat drops, which became round, and showed phenomena resembling ebullition, finally breaking up into smaller particles. The influence of the vapors of certain liquids on these films is often remarkable. A drop of ammonia on the end of a rod, when brought near an oil-drop resting quietly on the surface of water, causes its rapid expansion. If the experiment be made on a glass disk covered with a layer of water on which the oil-drop rests, the expansion begins when the rod is six or seven centimeters distant, and on closer approach the water is driven out and the oil-drop falls to the glass. Examining the phenomena under the microscope, Cintolesi found, 1st, that the films always contain swellings, which produce holes by their rupture, thus causing the

parting of the films; 2d, that the ebullition phenomenon was present in all the cases observed; 3d, that decrease of pressure or movement of the air in contact with the surface accelerated the formation of the film; 4th, that heat may increase the rapidity of expansion, or may stop it entirely, according to the conditions; 5th, that the ebullition disappears as the development of the film is more rapid; 6th, that no contractile liquid surface is necessary for this expansion, since it may take place within a mass of liquid or on the surface of solids. Closer microscopical examination showed that whenever a drop expands to a film, there is a development of gas, appearing to the eye under the form of round swellings, which move under the film from the thinner border to the centre, and reveal their true nature if the film becomes thin enough to break and allow them to be diffused. The phenomenon is well seen when almond oil is placed on a glass disk. Moreover, the appearance of ebullition above referred to arises from this development of gas, the two or three bubbles first formed uniting, and becoming the centres of action toward which the other bubbles tend. But as the larger bubbles do not continue to increase in size with the arriving bubbles, the gas would seem to be only the vapor of the expanded liquid. The bursting of these gaseous accumulations produces rents in the films, the spreading out of which, the author believes, is due to the fact that the gaseous molecules, moving in all directions, force the liquid molecules out horizontally in all directions, *i. e.*, along the surface.

The previous researches of Mensbrugghe, of J. Thomson, and especially of Tomlinson, had vastly extended our knowledge of the action of the surface-tensions of various liquids upon each other. But it appears that Cintolesi has reached a new manifestation of the phenomena which, though doubtless always accompanying surface-tension, is independent of it in many cases.—18 *A*, *October* 6 *and* 20, 1876, 85, 136.

METALLIC FILTRATION.

Professor Lampadius, of Freiberg, concluding that at a certain low temperature of fusion the metallic impurities present in the more easily fusible metals would separate, partially as such, and partially as definite crystalline com-

pounds, and float in the fused mass, from which they could be removed by filtration, made experiments in this direction, which were so far successful that the expected definite compounds were found upon the filter, though the metallic filtrate was still very impure. The filter was made of quartz sand, slag, etc., which was not wet by the molten metal. Subsequently Carter, in attempting to apply this method to the purification of Bohemian tin, as a commercial operation, sought to use for a filter a material which should be wet by the material to be purified, and at the same time should not be dissolved by it. For this purpose he chose iron, which, while it has a comparatively high temperature of fusion, has a strong adhesion to tin, as is evident in the tinned iron plate of commerce. Five hundred strips of tinned iron, as thin as paper, about 0.6 of an inch long, and one fourth as broad, were packed tightly in a square iron frame by the aid of wedges, and the frame was then luted into a suitable opening in the bottom of a graphite crucible. The tin, melted in a second crucible, was allowed to cool until the separation of fine crystals on the surface was noticed, the thickening metallic mass being then poured into the filtering crucible, when the still fluid pure metal passed through and a pasty magma was left, in which iron, arsenic, and copper, concentrated to a great degree, were found combined with tin, while the filtered tin proved to be almost chemically pure. Fifty hundred-weight were purified in the crucible described. Other forms and other materials for filters are suggested, and other possible applications of the method, as in the separation of silver from lead containing the former metal.—18 *A*, *October* 6, 1876, 89.

RESISTANCE OF THE ELECTRIC ARC.

Ayrton and Perry, of the Imperial College of Engineers, Tokio, Japan, desiring to determine theoretically the best arrangement of cells for the production of the electric light, have measured, as a necessary preliminary, the resistance of the electric arc. The first experiments were made with sixty new Grove cells—the immersed platinum plate being thirteen, and the zinc plate twenty-five square inches—used with a Duboscq regulator. The known resistance introduced consisted of many meters of bare copper-wire

hanging in the room, the thickness of the wire being sufficiently great to prevent any rise of temperature in it. By means of a Thomson quadrant electrometer the difference of potential between the carbon points was measured, and compared with that between the wire of known resistance. Since at any given moment the same current is flowing through the electric arc and the wire, the differences of potentials are proportional to the resistances. The alternate measurements succeeded each other closely, and were repeated many times. The resistance obtained never exceeded twenty ohms, and had an average of about twelve ohms; the variation being considerable even when the light was apparently steady. In a second series of experiments, eighty Grove cells joined in series, which had been in use occasionally for three hours after being set up, were connected with a differential galvanometer, in one circuit of which was a high resistance, in the other the electric arc, each galvanometer-coil being shunted with a wire of small resistance. When balance was obtained, the resistance of the arc, which, as before, varied greatly, never exceeded twenty-nine ohms, and averaged twenty ohms. From these results the authors draw the important conclusion that with such cells as they used no attempt should be made to join any of the cells in parallel circuit until at least two hundred have been joined in series; for if the resistance of each cell is about 0.2 ohm, two hundred of them would have a resistance of forty ohms—a resistance certainly less than double the electric arc for that battery corresponding with brightest light. Moreover, the authors have previously shown that the cells of a battery should be joined in series until the resistance of the battery is double the external resistance, at which point the battery should be joined in two rows, each containing half the number of cells in series, and the two rows connected in parallel circuit.—12 *A, October* 19, 1876, 544.

ACTION OF LIGHT ON EBONITE.

Herbert McLeod has called attention to the production of acid drops upon surfaces of ebonite or vulcanite exposed to the air by the action of light. It has long been known that the insulation of electrical apparatus made of this material is impaired by the formation of this conducting layer, which is

sulphuric acid due to the oxidation of the sulphur used in vulcanizing the rubber. It now appears that the production of ozone by electric sparks is not, as Wright supposed, the sole cause of the phenomenon. A plate of ebonite polished on both sides was sawed into four strips, each 52 mm. by 22 mm. by 8.5 mm., exposing therefore about 3500 sq. mm. of surface. One half of each piece was varnished with shellac. Two of these pieces were placed in wide test-tubes plugged with cotton-wool, and the other two were sealed hermetically in similar tubes. One of the sealed tubes and one plugged with cotton-wool were placed in a dark drawer, and the other pair exposed to light in the laboratory, and during the latter part of the experiment to direct sunlight. The experiment was commenced on December 26, 1874, and after some time minute drops of liquid were perceived on the ebonite exposed to light and air, the remaining three pieces retaining their original appearance. Between September 1st and 21st of this year the sealed tube exposed to light was accidentally broken, so that for a period of less than three weeks the ebonite in it was exposed to both light and air. On September 21st the tubes were opened, the ebonite washed with water, and the amount of acid determined by standard solution of caustic soda. No trace of acid could be detected on either of the pieces of ebonite which had been kept in the dark. On the one which had been exposed to light in the closed tube 0.343 milligrammes of sulphuric acid was found, and on that exposed to light and air 2.646 milligrammes. In confirmation of these results, the author notices an excellent instance of the action of light on vulcanite which occurred in the laboratory of Warren De la Rue. An apparatus with an ebonite base with three adjusting screws was standing at some distance from a window. The surface of the plate was covered with a fine dew of an acid liquid, except at the parts where the shadows of the heads of the screws fell. The surface at these places completely retained its original polish.—12 *A*, *October* 12, 1876, 525.

AMALGAMATION OF IRON.

In a paper read before the American Chemical Society, Casamajor describes a new method of amalgamating iron, which promises to render this metal useful for many novel

purposes. That iron may be made to combine with mercury is a fact discovered by Sir Humphrey Davy, whose process consists in immersing sodium amalgam in a saturated solution of ferrous chloride or sulphate. Cailletet, in 1857, showed that iron may be coated with mercury by means of ammonium amalgam, or by means of electrolysis. As the iron in both cases does not amalgamate till hydrogen appears, Cailletet concludes that the effect is due to the nascent hydrogen. Desiring to test the soundness of Cailletet's theory, Casamajor placed mercury in a beaker glass, covered it with acidulated water, and introduced a horse-shoe nail of Norway iron. Though a moderate escape of hydrogen took place, no trace of amalgamation appeared, even in twenty-four hours. Having to amalgamate a piece of zinc for another experiment, he placed the zinc in the beaker glass with the iron. The evolution of hydrogen from the nail increased at once very perceptibly, and after a short time the nail was found thoroughly amalgamated. Hence all that is necessary is to place the iron in acidulated water in contact with the mercury, and to add a few pieces of zinc; in a few minutes the iron will be coated with mercury. Since the zinc is attacked only when a more negative metal touches it, the consumption is very slight. The coating of mercury thus produced is not a superficial layer; the mercury sinks into the metal, modifying its physical and chemical properties, as is seen on fracture. No alteration in the tenacity of soft iron is observed, while hard-tempered steel has its brittleness much increased. In the voltaic circuit the amalgamated plate is positive to an unamalgamated one, and hence is more rapidly attacked. The quantity of mercury combined with the iron is very small. A piece of sheet-iron, presenting on both sides a total surface of three square inches, was amalgamated, and left to soak in mercury for over an hour. The mercury was then wiped off very thoroughly and the piece of sheet-iron weighed. The increase over the original weight was three centigrammes, which showed an absorption of mercury equal to a little over four centigrammes per square inch. The increase in weight of this thin sheet of iron was only three and a half per cent.; yet the fracture was silvery, and globules of mercury stood on the rough edge of the fracture. Platinum, palladium, aluminum, nickel, and

cobalt, all take mercury under the same conditions as iron. Aluminum, however, shortly after amalgamation, becomes hot, the mercury seems to boil, and the aluminum remains covered with a chalky crust, on removing which the metal is found beneath without a sign of amalgamation.—*Proc. Am. Chem. Soc.*, I., 1876, 49.

MUSICAL SAND.

In a communication to the California Academy of Sciences, Frink has stated that in order to ascertain, if possible, the cause of the sound that is produced by the musical sand from Kauai, previously exhibited to the Academy, he had investigated its structure under the microscope, and believed that the facts he had ascertained fully explain the manner in which the sound is produced. As the grains of sand, though small, are quite opaque, it was necessary to prepare them so that they should be sufficiently transparent to render their structure visible. This was effected by fastening them to a glass slide, and grinding them down until one flat surface was obtained. The grains were found to be chiefly composed of portions of small coral and apparently calcareous sponges, and presented under the microscope a most interesting object. The sand contained small black particles, which the microscope showed to be formed principally of crystals of nepheline and magnetic oxide of iron, imbedded in a glassy matrix. These were undoubtedly volcanic sands. The structure of these grains, Frink thinks, explains the reason why sound is emitted when they are set in motion. The motion against one another causes vibrations in their substance, and consequently in the sides of the cavities they contain; and these vibrations being communicated to the air by the cavities under the most favorable conditions for producing sound, the result is the loud noise which is caused when any large mass of sand is set in motion.—*Proc. Cal. Acad. Sci.*, 1876.

CAUSE OF SOUND IN ORGAN-PIPES.

It is stated in the ordinary text-books that in the mouthpiece of the so-called flute pipes of an organ the current of air which causes them to sound breaks against the upper lip into a series of intermittent impulses, by which the air in the pipe is set into vibration. Gonuch, however, who is an or-

gan-builder of Cologne, has thoroughly examined this subject, and has come to quite a different conclusion. He states that when a pipe is sounded, the blast being so arranged as to brush the upper lip of the pipe, the current thus produced carries continually out with it air particles from the interior of the pipe, the particles of course being those which lie nearest to the opening. Though a small portion of the current in passing to the lip goes into the pipe, yet the quantity of air which the current pulls out is considerably greater. Hence then arises, first of all, a rarefaction in the lower layer of air in the pipe. The exterior air now seeks to balance the rarefaction, but it can not at once reach it, either by the upper or the lower opening of the pipe. The air-column at rest in the pipe only yields to the outer atmospheric pressure when the rarefaction has extended to the middle of the pipe, where in the fundamental note of an open pipe the node is formed. At the lower opening of the pipe the blast current of course closes the aperture, and prevents the equilibrium there. Now at the moment in which the rarefaction in the lower part of the pipe has reached such a degree that the pressure of the external air is able to press the blast current inward, an air wave is cut off from the blast current at the upper lip, and a small momentary condensation is the result. This wave is propagated along the pipe, and at the middle it collides with the condensed wave which the pressure of the external air has simultaneously produced in the upper opening of the pipe or the air-column. Thus in the middle of the tube is formed a strong condensation, which may be called the acoustic wave, since from that time forth the peculiar vibration of the column and the phenomenon of sound are produced. It is evident, moreover, that at the moment when an air wave has detached itself from the blast current, and has removed the rarefaction in the lower part of the pipe, the blast current returns to its former condition or direction, and produces again its effect upon the air in the pipe. Again a rarefaction is produced, the blast current is again pressed inward, and with the consequent condensation the return of the acoustic wave of the node of vibration coincides. Thus the hypothetical impulses heretofore assumed are resolved into a pendulous oscillation of the blast current, which has its greatest amplitude at the edge of the upper lip,

is dependent on the elasticity of the air-column of the pipe and the pressure of the outer air, and so is subject to the laws of vibration of the air-column.—*Poggendorff's Annalen*, 1876.

OBLITERATION OF ONE SOUND BY ANOTHER.

Mayer, in the eighth series of his researches on acoustics, communicates certain striking results which he has obtained on the obliteration of one sound by another, from which he draws conclusions as novel as they are important. The investigation was suggested by observing the ticks of a watch making five per second, in conjunction with those of a loud-ticking clock making four ticks per second. On regulating the distance of the watch the fifth tick became fainter, until it disappeared entirely. An old silver watch, making four ticks per second, was then made to gain thirty seconds an hour on the clock, so that at every two minutes the ticks of the two coincided. When the watch was held at nine inches from the ear, its ticks were wholly obliterated for three seconds; and when at twenty-four inches, for nine seconds. As the time of coincidence approached, the short ticks of the watch glided tick after tick under the long ticks of the clock, more and more of the duration of each successive watch-tick became extinguished by the tick of the clock, until only the tail end of the short tick of the watch was left audible; and at last even this also crept under the long tick of the clock, and the whole of the ticks of the watch were rendered inaudible for nine seconds, at the end of which time the front or head of the watch-tick protruded beyond the clock-tick, and then slowly grew up into a complete watch-tick as before. Experiments were then made to measure the relative intensity of the two ticks, by placing both successively in the open air during a still night, and observing the distance at which they could be heard. The general result shows that the sensation of the watch-tick is obliterated by a coincident tick of the clock when the intensity of the clock-tick is three times that of the watch-tick. Extending the observations to musical sounds, Mayer observed in general the same phenomena. But he discovered here the new and remarkable fact that a sound higher in pitch than another can not obliterate it, no matter how intense. A curious effect of this law is observed if, while a man reads a sentence

over and over again with the same tone and modulation of voice, a c' pipe of 256 double vibrations be strongly sounded; it appears as if two persons were reading together, one with a grave voice (formed by a combination of all the reader's real vocal sounds below c' in pitch), the other with a high-pitched voice, generally squeaky and nasal, and of course disagreeable. This obliteration of higher by lower sounds, the author believes, has an important bearing on orchestral music. In the first place it will require the conductor of the orchestra to change his position to one nearer the midst of the audience. In the second, it will require a study of the relative intensity of the components of typical musical tones used in orchestral performances, so that those can be heard which the composer desires should be.—4 *D*, *November*, 1876, 329.

NEW METALLIC PYROMETER.

Though much improved of late years, pyrometers are not exactly all that could be desired. Hence the frequent appearance of new forms of that most desirable instrument. M. A. F. Huet, of Paris, has recently obtained provisional protection for an invention of this kind, being an instrument consisting of a rod of copper contained in a porcelain tube. The characteristic feature of the invention is said to be the particular arrangement of the bar of copper, which with its porcelain tube is inclosed in the wall of a furnace, into which the porcelain tube penetrates a suitable distance. Outside the furnace the tube terminates in a foot or support screwed down upon a plate. Inside the tube is the rod of copper, which is fixed at the inner end by means of a screw-nut at the end of the tube. This rod is prolonged outside the furnace, and terminates in a fork which embraces the vertical branch of a lever. To avoid all contact of the porcelain socket with the copper rod, an asbestus washer is arranged on each side of the screw-nut which fixes the rod and the socket at one end. To render the action of the heat from the furnace more direct upon the copper rod, small holes are pierced in the part of the socket which is inside the furnace. The lever is free to oscillate on an axis. The extremity of the other branch of the same lever is fastened by a joint to the top of a rod which carries a regulating screw-nut, this being terminated at the bottom by a piston destined to press

upon liquid in a cistern in connection with a glass thermometer or siphon tube up which the liquid passes, and indicates upon a gauge the heat of the furnace. The defect of this arrangement, apparently, lies in the fact that, after being submitted to high temperatures, the rod of copper would take up a permanent elongation, and refuse to expand or contract to the desired extent or with the desired accuracy.—18 *A*, 553.

CONDUCTION OF HEAT IN GASES.

The question of the conducting power of gases for heat is one which has received a large share of the attention of eminent physicists. The most recent of these researches is that of Winkelmann, who employed for measurement of the heat-conduction the same method which other observers have used; *i. e.*, he measured the rate of cooling of a thermometric body within a vessel filled with the gas to be examined. The difficulty of these experiments lies in the fact that the cooling is caused not only by the conduction of the gas which surrounds the cooling body, but also by the currents which are set up in the gas, and especially by radiation through it. Winkelmann addressed himself particularly to the task of eliminating these currents and the radiation. He effected this in one case by varying the pressure of the gas between 760 millimeters and one, since with diminishing pressure the action of the gas currents becomes less. In another experiment, he employed various apparatuses in which the cooling body within was always of the same dimensions and the same material, while the outer envelope was varied in size. The value of the radiation was then in all apparatuses the same, while the conduction varied with the size of the outer vessel, and so furnished data by means of which the radiation could be calculated and eliminated. The results obtained with several of the more common gases are as follows:

Gases.	Conductivity.	Gases.	Conductivity.
Air	0.0000525	Nitric oxide	0.0000460
Hydrogen	0.0003325	Carbonic oxide	0.0000510
Carbonic acid	0.0000317	Oxygen	0.0000563
Ethylene	0.0000414	Nitrous oxide	0.0000363
Marsh gas	0.0000647	Nitrogen	0.0009524

The fullest series of experiments were made with air and hydrogen, and the numbers obtained for these gases showed that in air, down to a pressure of one millimeter, the conduction of heat is independent of the pressure. Hydrogen, on the other hand, showed a quite divergent and hitherto unexplained behavior with reference to pressure, the changes of the currents in this gas with different pressures by no means affording an explanation of the observed differences in the velocity of cooling. In proof of this, for example, he states that whereas with a lowering of the pressure from 750 millimeters to 91.4 millimeters, there was a lowering of the value for the velocity of cooling of only 1.4 per cent.; yet that on further diminishing the pressure to 4.7 millimeters, there was a further decrease of 11 per cent., the decrease continuing when the pressure was still further lowered to 1.92 millimeters. Whether the circumstances operating in this case were accidental, or whether these anomalies are due to the properties of the gas itself, can be decided only by further and more exact researches. Besides the above question of simple heat-conduction in gases, Winkelmann also undertook to determine the relation in which heat-conduction stands to the temperature employed. In this investigation he had to employ new apparatus made of glass. He was also obliged to effect the separation of the conduction from the radiation on a different principle from that used in the former measurements. The observations were so arranged that first the time of cooling from 18° to 8° was determined, and then from 118° to 108°. With three apparatuses, very different in their dimensions, the author obtained the temperature coefficients 1.3661, 1.3429, 1.3644, referring to the temperatures 7.4° to 7.6°, and 107.7° to 109°. That is to say, if the heat-conduction at the lower temperature be put equal to one, then at the higher temperature it has the value just given. Besides air and hydrogen, carbonic acid was also examined in these researches. If the latter changes its heat-conduction with the temperature in the same way as air and hydrogen, it is obvious, by combination of the values of hydrogen and carbonic acid, that the same relative numbers should be obtained as those given by hydrogen and air. The values so obtained, however, are altogether smaller, whence it appears that the conduction of carbonic acid is not de-

pendent on temperature in quite the same way as that of hydrogen, but increases more quickly with the temperature. The value of these results in the theory of gases is very considerable.—*Poggendorff's Annalen*, 1876.

CREMATION IN FRANCE.

In December, 1875, a committee was appointed by the Council of Health and Hygiene of the Department of the Seine to consider and report upon the subject of cremation. This committee consisted of MM. Baube, Bouchardat, Boussingault, and Troost, the latter being the *rapporteur*. The report of this committee, after noting that the letter of the Prefect of Police did not suggest any special direction which the investigation should take, states that they confined their attention to the following points: (1) The possibility of effecting the incineration of bodies without production of smell or smoke or deleterious gases; (2) the advantages such incineration might offer as regards salubrity; and (3) the inconveniences it would present as regards criminal investigations. They did not have to concern themselves with the propriety of respecting the celebration of religious ceremonies; that propriety having been recognized by the municipal council, and by the administrative committee which fixed the programme of the competition for the invention of the best process for incinerating dead bodies, or of any other system giving a like result. It is, further, well understood, they say, that incineration would be in no wise obligatory, but simply optional, under conditions to be determined by a special law. With reference to the first question examined by the committee, the report is very brief. They do not doubt that by having recourse to gas furnaces, like those used in metallurgy, a rapid incineration could be had. It would be possible also to obtain, without any admixture of foreign matters, the ashes of bodies subjected to cremation. No fetid odor or smoke would be evolved, these furnaces being essentially smoke-consuming. Thus there would be no danger to public health to be feared. The conditions of the municipal council's programme might therefore be easily fulfilled, except perhaps that of economy, it being evident that until these furnaces can be occupied continuously they can not be operated economically. On the second point exam-

ined, the committee say that in their opinion cremation would present advantages over the mode of inhumation in a common graveyard, where insufficient space is reserved for each body. Fetid emanations and the alteration of subterranean waters may, in fact, result where the earth is saturated with organic matter in decomposition, and the air can not penetrate in sufficient quantity to produce a complete combustion. The most serious inconveniences of our present cemeteries, however, disappear where only a limited number of bodies sufficiently separated are contained in properly permeable strata. The land thus used might be returned to agriculture, after having been closed for a number of years; for the bodies buried in permeable soil are subjected to a sort of slow and indirect combustion, which does not present any inconvenience so long as the intermediate and dangerous products do not reach the surface of the ground. On the third point, the report asserts that inhumation presents guarantees for society which are not found in cremation, if the question be considered with reference to the investigation and determination of poisons, the existence of which is often not suspected till long after death. Dividing poisons into two classes, those which cremation would cause to disappear and those which it would not destroy completely, the committee say that in the case of the former class, in which rank all toxical substances of organic origin, and also arsenic, phosphorus, and corrosive sublimate—the very poisons, by the way, most commonly employed—cremation would obliterate all traces of the crime, would thus insure immunity from punishment, and so encourage the repetition of crime. In the case of the second class of poisons, which includes copper and lead, for example, while the metal might be found in the ashes, yet the persons interested would, it is clear, always have the opportunity of dispersing those ashes, or of replacing them with others; so that, in this event, the traces of crime would also be easily obliterated. For these reasons criminals might find in cremation a security which they have not in the present process of inhumation, and which it is important not to afford them, for it would be a source of more serious danger to the population than the insalubrity of cemeteries. The objections thus raised against cremation, however, would disappear if the law required that before any

such operation an autopsy of the body should be made and a chemical examination had of its principal organs, so as to ascertain the presence or absence of poison. But these examinations, which have value only when they are conducted in a truly scientific manner, are always delicate, even when the field of investigation has been limited by judicial instructions; and they would become extremely long and troublesome in the absence of any preliminary indication. Moreover, even if it be admitted that they would be conducted with the necessary care and skill so long as the number of cremations is small, it by no means follows that this would be the case when the demands for incineration multiplied.—*Annales de Chimie et de Physique*, V., viii., *August*, 1876, 571.

THE DIETHEROSCOPE.

Professor Luvini, of Turin, exhibited at the Scientific Loan Exhibition in London, and also at the International Exposition at Philadelphia, an instrument on a totally new principle for measuring atmospheric refraction. Its construction is as follows: If one half of a lens be covered, the image produced by it will differ only in brightness from that formed by the uncovered lens. Moreover, if we take two lenses of unequal focal length, and place them at a distance from each other equal to the sum of their focal lengths, the rays emerging from the second will have the same degree of convergence as those entering the first; *i. e.*, the object looked at will appear in its natural size and position. Any agency—such as irregular refraction of the atmosphere—which alters the path of the light from the object to the system of lenses will alter the position of the image formed. If now we have a telescope of such a size that the lenses of the dietheroscope cover half of the aperture of the object-glass, two images of the distant object can be formed—one as seen through the dietheroscope, the other as seen beside it; the latter image being formed by the rays coming directly from the object to the telescope. If the telescope is astronomical the latter image will be reversed, while that transmitted through the dietheroscope will be in its natural position. The distance between these two images will depend upon the refraction of the atmosphere, and so the instrument may be used to measure that refraction. Professor Luvini proposes that four of

his instruments be placed at each observatory, directed to the four cardinal points, and that by their means observations be taken at regular intervals of the condition of atmospheric refraction all around the observatory. He believes that by this method information of coming changes of weather can be obtained earlier than by the means now at the disposal of meteorologists.—18 *A*, *August*, 1876, 558.

IMPROVED MODE OF MOUNTING MICROSCOPIC OBJECTS.

Professor Hamilton L. Smith, of Hobart College, New York, has communicated to the *Journal* of the Microscopical Club a new method of making cells of moderate depth, designed for opaque objects, which is at once simple and easily put in practice. The wall of the cell is made of a brass curtain-ring. Out of a sheet of dark-green or black wax a disk is punched, a trifle larger than the ring, which is fastened to the centre of the slide by melting. The ring is pressed into this, centred, pressed quite through, and the whole finished with Brunswick black. The object is attached to the wax by previously moistening it with turpentine. The cover is dropped just within the ring, its surface being flush with it, and fastened with the black varnish. The soft and delicate appearance of these wax backgrounds gives an exquisite finish to the slide, the absence of obvious cementing material for the object lending an additional charm. Dr. Smith also uses the sheet wax for cells, cutting rings out of it of any desired color, and attaching these both to the slide and cover by slight fusion. The rings are prepared by means of a specially devised press, consisting of a plunger the size of the hole, a centring and a supporting plate. Disks of the sheet wax are dropped in and the hole made in them, the plunger being wetted to prevent adherence.

CURIOUS JAPANESE COMPASS.

Captain J. H. Murray, of the screw-steamship *Scaresbrook*, obtained from a Japanese pilot at Yokohama, in 1874, a remarkable compass, a description of which has been given to the public by Buckland. The compass was taken from the wreck of a junk which had been lost on the island of Vries, a volcanic island at the entrance to Yokohama, the smoke of which, with the snow-capped peak of Fusiyama, indicates the

entrance to the harbor. The pilot could give no information about the compass, except that it was found on board the wreck. It is of a circular form, measuring 13.5 inches across, is cast in bronze, and weighs twenty-one pounds. It has a thick rim, in which two ordinary compasses are set, one on each side. The centre of this remarkable plate-like looking object is considerably raised from the surface, and is covered with a number of raised spots or stars of various sizes, each more or less connected by lines with its neighbors. The shapes of these star-like objects are remarkable; in the centre there are five which are larger than the rest. Then there is another group very like a net; another group represents almost a complete circle of these stars; another represents a Y, with the arms closed together; another a Y with the arms extended. Altogether there are no less than two or three hundred of these elevated spots of different sizes. Running throughout the whole series are several lines radiating from a circle drawn around the centre. The brass rim on which the compasses are set is divided into 360 degrees, the same as in an English compass. At every thirty degrees there is a Japanese character. Neither Captain Murray nor any one to whom he has shown this curiosity at home or abroad has any idea whatever of the meaning of the star-like bodies in the centre, or for what purpose the Japanese used them; but it is quite certain that they must have been of some use to them. It is most interesting that these rude characters should be united in the same instrument with the 360 degrees of modern civilization. The casting of the instrument is marvelous.—2 *A*, 1876.

CLAMOND'S THERMO-ELECTRIC BATTERY.

The latest form of the Clamond battery consists of an alloy of two parts of antimony and one of zinc as the negative metal, and ordinary tinned sheet-iron as the positive element, the current at the heated junction flowing from the iron to the alloy. This alloy is cast in the form of a flat bar, broader in the middle than at the ends, and measuring from two inches to two and three-quarter inches in length, by three eighths to one inch in thickness. The sheet-iron, properly stamped out, is placed in a mould into which the melted alloy is poured; before the alloy has cooled the mould is open-

ed and the bars are removed. The alloy melts at 500° Fahr., and expands considerably on cooling. It improves on recasting, but is always very brittle. The bars are arranged radially around a temporary brass cylinder, a thin slip of mica being inserted between the iron and the alloy to prevent contact except at the point of junction. Eight or ten of these bars form a ring, and the several rings are placed one above another, insulated from each other by a circle of asbestus. The inner ends of the bars are heated by a Bunsen burner, the flame issuing in small jets in the annular space between the burner and the bars. The consumption of gas is said to be one cubic foot for each volt of tension per hour. The electromotive force of this combination is such that twenty elements are about equal to one Daniell cell—about one volt. The following table, given on the authority of Latimer Clark, gives the constants of these batteries as sold in London:

Coupled.	Size.	Electromotive force.	Internal resistance.	Consumption of gas—cub. ft.
Tension..........	40 bars.	2 volts.	1 ohms.	..
"	60 "	3 "	1.5 "	3
"	120 "	6 "	3 "	5
"	150 "	7 "	3.75 "	6
"	240 "	12 "	6 "	9
"	380 "	19 "	6.75 "	23
"	680 "	34 "	12.25 "	37
Quantity..........	50 "	2.5 "	0.25 "	6
"	60 "	3 "	0.6 "	6
"	100 "	5 "	1 "	9
"	200 "	10 "	2 "	23
"	400 "	20 "	4 "	37

When hot, the resistance of the batteries rises about 25 per cent. The smallest of the above piles costs about $15, the largest about $150. A battery of 375 pairs—the internal resistance of which was 4.5 ohms, and the electromotive force 14.6 volts—deposited 180 grains of copper per hour. The electric light which they give is powerful and constant; but it requires a large number of elements.—*Telegraphic Journal*, 1876.

THE GRAMME LIGHT IN RAILROAD DEPOTS.

Sartiaux has communicated to the French Academy the results of his experiments on the practical use of the electric

light of the Gramme machine in illumination, undertaken at the request of the Compagnie du Nord, their stations being used for the purpose. The machines selected for the trials were those rated at 50, 100, and 150 Carcel burners respectively, equivalent to 350, 700, and 1050 candles. The experiments were made in the baggage-room and in the station itself; the former having an area of about 16,000 square feet and a volume of about 670,000 cubic feet, the latter an area of nearly 120,000, and a volume of 10,500,000 feet. The force used was derived from both steam and gas motors, the power being measured with a Prony brake. The Serrin lamp was employed. The results obtained are tabulated as follows :

			Machine 1.	Machine 2.	Machine 3.
Revolutions per minute			1650	800	800
Power required to insure a steady light...	carbons, 6 millimeters sq.		2.2 h. p.	2.4 h. p.	2.5 h. p.
	carbons, 9 millimeters sq.		" "	2.6 "	2.7 "
Consumption of carbon and waste.......	carbon, 7 mm...	pos. pole,	" "	0.090 meter.	0.13 meter.
		neg. pole,	" "	0.045 "	
	carbon, 9 mm...	pos. pole,	" "	0.060 "	0.09 "
		neg. pole,	" "	0.030 "	
Distance at which reading was easy.......			25 meters.	40 to 45 mtrs.	45 to 58 mtrs.

As M. Tresca showed, the force necessary to produce a light, say of 700 candles, increases rapidly as the total light diminishes. The light being 12,950, 2100, 1050, 700, and 350 candles, the force required is 0.415, 0.920, 1.7, 2.4, and 4.4 horse-powers respectively per 700 candle-lights. Moreover, it will be observed that a little more force is needed to get the light from carbons nine millimeters square than from those which are seven. Calculating the expense of this light as compared with gas, Sartiaux finds that a gas-light of 700 candles requires a consumption of 15.75 cubic meters of gas per hour, which, at the price of 0.3 franc per cubic meter, would cost 5.7 francs ($1.14). The electric light of the same power requires 2.7 horse-power, which, at 0.09 franc per hour, is 0.24 franc. Add to this 0.09 for the carbons, 0.45 for engineer, 0.20 for interest, etc., the total expense is 0.98 franc (nearly 20 cents); being between a fifth and a sixth of the expense of gas. Moreover, the greater extent of surface illuminated increases this difference exceedingly; since to give the same illumination with gas would certainly require at least twenty-five

additional burners. To avoid the glare, the light was inclosed in a globe of ground glass.—*Revue Industrielle*, VII., *May*, 1876, 169.

MAGNETISM OF COBALT AND NICKEL.

It has long been known that a bar of iron when magnetized becomes appreciably elongated. Barrett has recently sought to discover whether cobalt and nickel are similarly affected. With cobalt, a slight lengthening may be perceived; but in the case of nickel a contraction, about equal to the expansion of iron, takes place. The bar of nickel used was about two feet long.—1 *A*, *June* 30.

D. CHEMISTRY AND METALLURGY.

CHEMICAL ACTION OF SOLAR RAYS.

Henry E. Roscoe states that although his method of measuring the varying intensity of the chemically active rays as affecting chloride of silver paper has been the means of pointing out many important facts, yet it has not been introduced as a regular portion of the work of meteorological observatories; until which is done we can not hope to obtain any thing like a complete knowledge of the laws of distribution of the chemical rays over the earth's surface. This neglect of Roscoe's method is, in part at least, due to the labor of observing. He has, therefore, advised a modification of the instrument described by him in 1865, and as thus modified the constant sensitive paper is exposed to the action of total daylight at given intervals, say at every hour during the day, by a self-acting arrangement for accurately noting the times. These hourly records are then read off in the evening by the observer. Many mechanical difficulties have been overcome through the skill of Mr. Jordan, of Manchester, and the instruments, as described by Roscoe in the last volume of the "Transactions of the Royal Society of London," are said to give complete satisfaction. In order to read off the intensities of recorded photographic images, a standard series of graduated tints is provided. Special directions are given for the preparation of the sensitive paper. The correction due to the reflection and absorption of the glass cover is also investigated; and the comparison of observations made by hand, and by the self-recording instrument, over twenty days with the two methods, closely agree.—*Philosophical Transactions, London*, 1875, 655.

OCCLUDED HYDROGEN IN SO-CALLED EXPLOSIVE ANTIMONY.

The presence of a considerable amount of chloride of antimony was demonstrated several years ago, by Professor Böttger, in the so-called explosive antimony formed on the negative pole, consisting of fine platinum wires, the positive one being of massive antimony, when the current of a single

Bunsen element is passed, for three or four days, through officinal solution of terchloride of antimony, with a resistance of about eight hundred feet of copper wire in the circuit. He has recently also detected occluded hydrogen in it, possessing identical reducing properties with the hydrogen absorbed by palladium. Thus, if the platinum wires, covered with recently deposited explosive antimony, are placed in a very dilute aqueous solution of ferricyanide of potassium, the partial conversion of the latter into ferrocyanide will be evident in the course of ten or fifteen minutes. Pure antimony, perfectly free from arsenic, will not produce such a result. Since the liquid employed is a hydrochloric-acid solution, the liberation of gaseous hydrogen at the negative pole, with the antimony, by decomposition of the acid, might be expected, but not the slightest trace of it could be detected, while, on the other hand, the presence of chlorine at the negative pole, in combination with antimony, without the evolution of hydrogen, is so remarkable that it seems desirable to test other metallic chlorides thus electrolytically.—15 *C*, XXII., 1875, 337.

AMERICAN BROMINE.

The increased demand for bromine, after the introduction of potassic bromide into medicine in 1866, led to its preparation from the mother liquor at the different salt-works of Pennsylvania, and subsequently at those of Ohio and West Virginia. The method employed is the usual one with binoxide of manganese and sulphuric acid. From 1867 to 1870 the production increased from 11,000 pounds to 194,000 pounds. Up to 1870 all was consumed in the United States, but since then it has been exported. The price, however, has been so depressed by excessive production that no new works for its preparation are being established. —18 *C*, *February* 9, 1876, 95.

DETERMINATION OF OZONE IN THE AIR.

The determination of the quantity of ozone in the air has not yet been achieved by any convenient method, since the tint of the ordinary ozone test-papers is determined by the velocity of the wind. It was supposed by Von Pettenkofer that the absence of the ozone reaction in the atmosphere of closed dwelling-rooms was due to the slight circulation in

the air. This subject has, however, been fully investigated by Wolffhugel, who finds that, while a given quantity of fresh air yields a very visible ozone reaction, yet ten or twelve times that quantity taken from the interior of dwellings produces no effect, even when the rooms are unused, having previously been well aired. Wolffhugel has also shown that there is a great absence of ozone in the air near the ground.—7 *C*, 11, 122.

DECOMPOSITION OF WATER.

Gladstone and Tribe find that when aluminum foil and iodine are placed together in water, hydrogen is copiously evolved. The same phenomenon takes place if aluminic iodide be substituted for iodine, its formation really being the first part of the reaction just described. Aluminic bromide or chloride acts in much the same manner, the aluminum used being almost completely oxidized. The same experimenters sought to determine whether zinc or iron, heated with solutions of their respective iodides, would yield hydrogen, and obtained only negative results. These metals, however, with aluminic iodide in water, produced readily a copious evolution of the gas. Aluminum alone decomposes water, according to Deville, only at a white heat. But Gladstone and Tribe, by simply coating aluminum foil either with copper or platinum, procured couples which effected the decomposition quite easily at the low temperature of 100° Centigrade.—21 *A*, 822, *September*, 1875.

DECOMPOSITION OF WATER BY PLATINUM.

Deville and Debray find that when a mixture of potassium cyanide and spongy platinum is heated together in the neighborhood of a little water, at about 500° or 600°, a vacuum having first been established, great quantities of hydrogen are evolved, and the well-known platino-cyanide of potassium is formed. The hydrogen is not pure, but contains small quantities of ammonia, and from four and a half to twelve per cent. of carbonic oxide.—6 *B*, *January* 24.

CRYOHYDRATES.

About a year ago Professor Guthrie described under the above name a set of hydrates which exist only at very low

temperatures. Whenever a crystalline salt is dissolved in water and the solution frozen, solidification takes place *below* the Centigrade zero, and a definite compound of the water with the salt is formed. And whenever any crystalline salt is mixed with ice or snow, the same compound is formed, and a fall of temperature ensues. Hence with every crystalline salt a freezing mixture may be prepared. Guthrie now extends his observations to colloid bodies, and shows that they act very differently from the crystalloids. Thus from a solution of gum, gelatin, or albumen all the water separates as ice at 0° Centigrade, and no cryohydrate is produced. This new distinction between crystalloids and colloids seems to be of the very highest importance.—1 *A*, *June* 30.

NATURAL DEVELOPMENT OF SULPHURETTED HYDROGEN.

Faulquier narrates a curious phenomenon which took place during the summer of 1875 at Palavas, near Montpellier. In the vicinity of this place are extensive salt marshes, which, in consequence of persistent north winds, have become almost dried up. The accompanying heat of the season has produced a rapid decomposition of the organic matter in the soil, which has been accompanied by a development of sulphuretted hydrogen. The existence of this gas has been very palpable to the senses, and has also produced an unexpected influence upon the residences near by, the painted surfaces of the houses having first turned brown, and finally almost entirely black, while the paint even in the interior of the houses has become much altered. All silver and silvered objects have also become blackened by the same influences. Another effect is that of loosening and crumbling away of the plaster between the joints of the building-stones, which Faulquier attributes not to the sulphuretted hydrogen, but to the saline particles contained in the atmosphere.—1 *B*, *September* 5, 346.

AMMONIA IN SULPHURIC ACID.

Professor F. H. Storer finds that ammonia in traces is an invariable contaminant of sulphuric acid. Nine samples of acid were examined from different manufactories, seven being obtained direct from the makers. These were kept previous to examination in tightly stoppered bottles, and in every case

the portion tested was taken from the middle of the bottle containing it. The same impurity, ammonia, was also found in a very large number of other chemicals in the preparation of which sulphuric acid is employed. Professor Storer thinks that the ammonia may get into the acid, partly from the air, partly from the water employed, partly from a reduction of the nitric acid used in oxidizing the sulphur dioxide formed in the first stage of the sulphuric manufacture. In fact, he finds by direct experiment that whenever dilute nitric acid is made to act either upon lead or sulphur (as in the leaden chambers of sulphuric-acid works) traces of ammonia are produced.—4 *D*, *December*, 1875.

AMMONIUM NITRITE.

This extraordinary substance has been reinvestigated by Berthelot, who obtained it by double decomposition from barium nitrite and ammonium sulphate. The filtered solution, evaporated over quicklime in vacuo, yields crystals of the substance desired. It is also formed by the simultaneous reaction upon each other of nitrogen tetroxide, dry ammonia, and oxygen. It forms a white, crystalline, deliquescent salt, having peculiar elastic properties. It decomposes slowly at ordinary temperatures; at 60° to 70° Centigrade it explodes violently; under a severe blow it detonates. In solution the salt, anomalously, decomposes more rapidly than when dry; heated, torrents of nitrogen are evolved. It seems to be one of the least stable bodies known.—*Annales de Chimie et de Physique.*

ACTION OF NITRIC ACID ON METALS.

The subject indicated by the heading of this paragraph has recently been studied by Mr. J. J. Acworth, who explains some points which have often led to confusing uncertainties. Thus nitric acid, acting in the cold on copper, should yield nearly pure nitric oxide, but does not always. Acworth finds that as cupric nitrate accumulates in the solution, nitrous oxide begins to be formed; and that when the above-named salt becomes sufficiently abundant the latter gas is given off almost alone. If ammonic nitrate be added to the nitric acid during its action on copper, the gases evolved consist chiefly of nitrogen with nitrous oxide, and

smaller quantities of nitric oxide. The acid, acting upon zinc or mercury in the presence of ammonic nitrate, yields little gas but nitrogen; with silver, nitric, but no nitrous oxide is also formed.—21 *A*, *September*, 1875.

CONSTITUTION OF PHOSPHORUS OXYCHLORIDE.

The constitution of phosphorus oxychloride has long been a matter of discussion. Ira Remsen now shows that the compound may be formed by the direct action of ozone upon the trichloride. This fact strengthens the view which regards phosphorus as pentatomic, and obliges us to look upon the atom of oxygen in the oxychloride as directly satisfying the two bonds of affinity left free in the trichloride.—4 *D*, *July*.

DISCOVERY OF VANADIC ACID IN MAGNETIC IRON.

Dr. Isidor Walz communicated to the American Chemical Society, May 4th, that he had discovered 0.3 to 0.4 per cent. of vanadic acid in magnetic iron ores from the Church Mine, New Jersey. Apart from the scientific interest attaching to the rich occurrence of that rare metal on our soil, this discovery may lead to important practical results, as the salts of vanadium have recently begun to play an important *rôle* in the preparation of aniline black, indelible marking-ink, etc., and the supply has hitherto come from much poorer sources than the one now disclosed.

CARBON FROM THE ROOF OF A GAS-RETORT.

Mr. A. McDougall exhibited before the Manchester Literary and Philosophical Society a specimen of carbon obtained from the roof of a gas-retort, resembling graphite in its almost metallic lustre. It was undoubtedly produced by the decomposition of the hydrocarbon gases in the intense heat of the retort; and it is suggested that its formation may throw some light on that of graphite, as that substance is always associated with rocks that have been subjected to igneous action.—18 *A*, *April* 9, 1875, 89.

LIQUID CARBON DIOXIDE IN MINERAL CAVITIES.

W. Noel Hartley, examining the liquid which occasionally occurs in the cavities of quartz, has corroborated the conclusions of Davy and Brewster with regard to its being lique-

fied carbon dioxide. He noted that at the temperature of about 31° Centigrade the liquid in such a cavity disappeared entirely, to return upon cooling. Dr. Andrews gives 30.92° Centigrade as the critical temperature of carbon dioxide, so that there can no longer be any doubt concerning the nature of the liquid under examination.—1 *A*, *March* 26.

CARBON MONOSULPHIDE.

Sidot finds that when carbon disulphide, inclosed in hermetically sealed tubes, is exposed for about two months to the action of sunlight, brown flakes of the new monosulphide, C S, are deposited. This substance, dried and purified, is a chestnut-brown, tasteless, odorless powder of 1.66 specific gravity. It is insoluble in water, alcohol, turpentine, or benzol; boiling ether or carbon disulphide dissolves traces of it. Hot nitric acid dissolves the monosulphide to a red liquid; but chlorohydric acid is without action upon it. A boiling solution of caustic potash takes it up freely, forming a blackish brown liquid, from which acids reprecipitate the substance. At 200° Centigrade the new sulphide decomposes, sulphur distilling off, and carbon remaining behind.—18 *C*, 1875, *September* 29.

A NEW CLASS OF CYANIDES.

Gaston Bong, studying potassium ferrocyanide and some of its derivatives, has obtained a remarkable new double salt. It is formed by treating a mixture of the common yellow prussiate and potassium chlorate with sulphuric acid until a persistent blue color is produced. The resulting mass is heated gently, extracted with water, neutralized with sodium carbonate, boiled and filtered. This solution, by careful crystallization in vacuo, yields black crystals, which, readily soluble in water, give it an intense violet color. The compound may be regarded as the type of an entirely new class of double cyanides, and its relation to well-known ferro- and ferricyanides may be indicated by formulæ:

Potassium ferrocyanide............K_2FeCy_3
Potassium ferricyanide............$K_3Fe_2Cy_6$
New compound..................$K_4Fe_4Cy_{12}$

Thus, in this series, every added potassium atom needs a doubling of all the other atoms in the molecule. The new

salt is a powerful oxidizing agent, and produces greenish precipitates with metallic solutions.—*Bull. Soc. Chimique*, 1875, *October* 5.

IMPROVEMENT IN THE AMMONIA-SODA PROCESS.

The following improvement in the ammonia process for the manufacture of soda has been patented in England. The solution of chloride of ammonium formed is mixed with carbonate of magnesia and distilled, and the carbonate of ammonia, which passes over, is again used in the manufacture of soda. The solution of chloride of magnesium remaining, which also contains some chloride of sodium, originally present with the chloride of ammonium, is concentrated, and the chloride of sodium removed from time to time as it crystallizes out. What remains is then calcined with the formation of hydrochloric acid and magnesia. The latter is reconverted into carbonate by the gaseous products of combustion from the furnace. The separation of the chloride of sodium before the calcining is important, as otherwise the chloride of magnesium will not be decomposed by heat alone. A partial decomposition of the chloride of magnesium, however, is said to be more favorable to the conversion into carbonate than complete decomposition.—5 *C*, XXXVIII., 1875, 303.

MANUFACTURE OF SODA FROM SEA-WEED.

Herland, in *Comptes Rendus*, calls attention to some defects in the treatment of sea-weed for the manufacture of soda, and makes some suggestions for an improvement of the process. He remarks that in the ordinary method the weeds destined to be calcined are dried on the shore in the open air, involving decomposition and a loss of salts by moisture, and that the process of incineration is itself defective. The method by which he proposes to remedy the difficulty is as follows: Place the fresh weed in baskets of iron wire, moved by a turning crane, and steeped in a series of vats containing about fifty kilogrammes of good quicklime per cubic meter, and so placed that it can pass in succession from vat to vat until it is exhausted of its useful salts. The time of steeping in each vat is from forty to sixty minutes. The successive saturated lyes are to be reduced to dryness and treated with carbonate of potash. This will yield a

soda very rich in soluble salts and alkaline iodides. While the incineration gives but fifteen per cent. of potash and one per cent. of iodide, the new process yields forty to fifty per cent. of potash, and sometimes six per cent. of iodide. The residual weeds are applicable to agricultural purposes.—1 *A*, *July* 21, 1876, 32.

ATOMIC WEIGHT OF CERIUM.

Bührig, by means of a series of careful combustions of cerium oxalate, has very accurately redetermined the atomic weight of the metal. This, based upon the values given by Stas for carbon and oxygen, he finds to be 94.1782. This value is the mean of results obtained in fifteen experiments. —*Journal für prakt. Chemie*, XII., 209.

THE CERIUM METALS.

The rare metals cerium, lanthanum, and didymium have at last had their atomic weights definitely fixed by Hillebrand. He determined the specific heat of each metal by means of Bunsen's ice calorimeter, getting the following values: Cerium, 0.04479; lanthanum, 0.04485; didymium, 0.04563. These figures, considered with reference to Dulong and Petit's law, correspond respectively to the atomic weights 138, 139, and 144.78. These observations prove that the lower oxides of these metals are really sesquioxides, and the higher oxides, dioxides. Until lately the atomic weights of this group have been rated at only two thirds of the above values.—*Poggendorff's Annalen*, 1876, No. 5.

CERIUM, LANTHANUM, AND DIDYMIUM.

These rare metals have recently been isolated in quantity by Drs. Hillebrand and Norton, students under Bunsen at Heidelberg. Cerium outwardly resembles iron, is very ductile and malleable, and tarnishes readily. In hardness it about equals silver, and its melting-point is at a full red heat. Heated in the air it kindles very easily, at a lower temperature even than magnesium, burning with great brilliancy. Upon shaving a cerium wire with a knife the thin fragments of metal ignite as they are cast off, while with an ordinary fire-steel sparks can be struck from it as from a flint. Didymium and lanthanum resemble cerium closely, but are less

inflammable, and do not tarnish so easily. The specific gravities are as follows: Cerium, 6.628 to 6.728; lanthanum, 6.049 to 6.163; didymium, 6.544. In their electrical relations the three metals lie between magnesium and zinc; they are electro-positive to the latter, electro-negative to the former.—*Poggendorff's Annalen, March* 25, 1875.

EXPERIMENTS ON STEEL.

MM. Trève and Durassier have communicated to the French Academy the following results of their investigations into the relation existing between the chemical and physical properties of steel. They prepared fifteen bars of steel, divided into five series of three bars, each series being of a different degree of carburation, and each tempered in a different manner. These bars were then magnetized to saturation, and their magnetic force determined by the method of deflection. The bar containing 0.95 per cent. of carbon, and tempered with cold water, caused the maximum of deflection, represented by 47. The bar containing the same amount of carbon, but tempered with oil at 10° Centigrade (50° Fahr.), gave 43. That the magnetic capacity of steel is influenced by the nature of the liquid used for tempering seems therefore to be manifest. The bar containing 0.25 per cent. of carbon gave a deflection represented by 13, showing how decided is the influence which it exerts. In preparing diagrams of variations for the different series of bars, the influence of the percentage of carbon and of the tempering liquid became manifest. It was remarked, however, that at the top of the scale in carbon, the nature of the tempering liquid no longer exerted a very marked influence. The study of these diagrams brought to light, likewise, the noteworthy fact that a remarkable similarity existed between the magnetic curves and the curves of elasticity of the bars. The investigators assert from their experimental trials that carbon gives elasticity to the steel, and at the same time enhances its capacity for magnetism.—3 *A*, V., 556.

·NFLUENCE OF FOREIGN INGREDIENTS UPON THE PHYSICAL PROPERTIES OF STEEL.

·perience that has of late been gained in the pro-
hosphuretted steel may be characterized as a

triumph which promises the most substantial results for this important branch of metallurgical industry. It has been demonstrated that the peculiar properties of steel are not governed absolutely by the presence of a certain percentage of one or two substances, like phosphorus or carbon, but that these properties may be secured and modified at pleasure by judiciously controlling the relative proportions of a number of foreign ingredients introduced into the metal. The progress that has been made in this direction has been intelligently summarized by *The Engineering and Mining Journal:* "By securing the proper relative proportions of carbon, phosphorus, silicon, and manganese, a steel of great softness and strength can be obtained, while the same percentage of phosphorus in an ordinary steel would have indicated very different properties (which means, in other words, that it would have been quite worthless). There can no longer be much doubt that manganese exerts upon steel a body-giving, toughening influence, as well as a neutralizing effect upon the hardening or cold-shortening due to phosphorus. Though these properties of manganese have been suspected for some time, the mutual dependence, and to a certain extent interchangeability, of carbon and phosphorus were not fully appreciated until M. Tessié du Motay succeeded in producing with ferro-manganese a good steel rail, containing about 0.12 per cent. of carbon, 0.25 of phosphorus, and 0.75 of manganese." In the light of the recent investigations, therefore, phosphorus is no longer entitled to the evil distinction of being, as a well-known metallurgist has expressed it, "the very scourge and pestilence of the steel-maker," and the time is possibly not far away when many rich deposits of ore now esteemed to be worthless will find ready utilization.

GALLIUM.

M. Boisbaudran states that in his first discovery of gallium he did not possess more than one hundredth of a milligramme of the metal dissolved in a minute drop of liquid. Lately, with a larger supply of material, he has determined some of its characteristics. The spectrum is exceedingly brilliant, giving with a gas flame the line 417; in a spark spectrum line 403.1 also appears. The metal can be deposited

electrolytically upon copper, forming a hard layer, difficult to burnish and rather whiter than platinum. It was originally found in a blende from the Pyrenees, but has since been detected in blendes from various other sources, so that the discoverer thinks it may be quite widely diffused. Its most important chemical feature is that it forms apparently a true alum, thus belonging with indium and aluminium in classification. This fact is particularly interesting when considered in connection with a brief article by Mendelejeff. This author some few years ago, in his paper upon the "periodic law," ventured upon theoretical grounds to predict the existence of several then unknown metals. In all probability gallium is one of these, and will fill a gap which Mendelejeff pointed out in the aluminium group. The verification of such a prophecy might well afford a parallel to the discovery of the planet Neptune.—1 *A*.

GALLIUM.

M. Boisbaudran has succeeded in isolating about half a gramme of this new metal, and has redetermined some of its leading characteristics. In the fused state it is of a fine silver white color; but in crystallizing it assumes a pronounced bluish tint, and loses considerably in brilliancy. The metal, by cooling from fusion, may be obtained in isolated crystals, which are octahedral. The melting-point, previously put at 29.5° Centigrade, is now, as a mean of six closely agreeing measurements, fixed at 30.15°.

Great interest attaches to the specific gravity of gallium. A few months ago it was determined to be 4.7 at 15° Centigrade, the determination being made with a specimen of metal weighing only six centigrammes. But, calculated upon the basis of Mendelejeff's law—the law by which the existence of gallium was predicted—the value should have been 5.9. Two new determinations, now published by Boisbaudran, give 5.935 and 5.956. This agreement with theory is very close and very striking.—6 *B*, LXXXIII., 611, *September* 18.

DESILVERIZATION OF ARGENTIFEROUS ZINC.

The desilverization process introduced by Parkes in 1850, but subsequently neglected in consequence of the difficulty

of recovering the metallic zinc so as to be re-employed in a continuous process, has been again brought into operation at Tarnowitz, in Silesia. The argentiferous zinc crust is now allowed to cool in an iron basin, then placed in the liquating furnace, where, by gentle heating, with full access of air, it is deprived of the greater part of its lead. By this means the zinc is thoroughly oxidized and converted into the so-called zinc dust, which is then distilled between layers of powdered coke, with the production of metallic zinc, free from silver, on the one hand, together with a residue containing the whole of the silver, along with any lead remaining in the zinc dust. —18 *A*, *April* 9, 1875, 89.

ON THE FUSIBILITY, ETC., OF ALLOYS OF SILVER AND COPPER.

Mr. Roberts, chemist to the English Mint, has communicated to the Royal Society the result of a detailed elaborate investigation into the liquidation, fusibility, and density of certain alloys of silver and copper. The melting-point of the several alloys experimented upon by him varied from 840° Centigrade to 1330° Centigrade, the most fusible alloys being those that contain from sixty to seventy per cent. of silver; and the fusibilities vary very much as to the electric conductivities. The density of pure silver, when fluid, is 9.46; its density when solid is 10.57. This alloy, therefore, on becoming fluid, expands at nearly double the rate that it expands when at ordinary temperatures. Mr. Roberts has also succeeded in obtaining excellent results in the electro-deposition of iron, for which purpose he employs a solution of the double sulphate of iron and magnesia. The iron thus obtained possesses a higher electric conductivity than any commercial iron, and occludes thirteen times its volume of hydrogen. The tube of the metal, which was a vacuum tried at the ordinary temperature, allowed hydrogen to pass through it freely at a dull red heat.

A NEW TEST FOR GOLD.

M. Sergius Kern, of St. Petersburg, in studying the behavior of certain double salts of gold, made the observation that the sulpho-cyanide of potassium was a most sensitive reagent of this metal, which, as experiment proved, would

indicate the presence of less than the 0.001 of a gramme of gold. He proposes the following procedure: The gold of the sample under analysis is first separated in the usual manner from foreign metals, and next converted by means of sodium chloride into sodio-gold chloride ($NaAuCl_4$); the solution is then concentrated by evaporation. In order to detect the presence of gold, an aqueous solution of potassium sulpho-cyanide (KCyS) is employed, which should contain, for one part of the salt, about fifteen to twenty parts of water. About six grammes of this solution are poured into a test-tube, and some drops of the suspected gold solution, treated in the manner above described, are added. If gold is present, a red-orange turbidity is at once obtained, which soon falls in the form of a precipitate. On gently heating the contents of the test-tube, the precipitate dissolves, and the solution becomes colorless. This reaction is said to be so delicate that one drop of a solution of the sodio-gold chloride (one gramme of the salt in forty grammes of water) affords a decided reaction. The reaction indicates, according to the observer, the formation of a double sulpho-cyanide. —1 *A*, XXXII., 171.

PURE PLATINUM AND IRIDIUM.

Deville and Debray, obtaining pure platinum and iridium in quantity, have found for these metals rather higher densities than are commonly ascribed to them. The platinum has a specific gravity of 21.5, while that of iridium is 22.421. An alloy containing eighty-five per cent. of platinum to fifteen of iridium, with density 21.618, was found to be very ductile and malleable, and yet quite rigid. Probably it would be useful in the arts. An alloy containing only 66.67 per cent. of platinum, on the other hand, was not malleable.—*Supplement to* 7 *A*, *December*, 1875.

OSMIUM.

According to Deville and Debray, osmium is the heaviest substance known, having a specific gravity of 22.477. They have prepared the metal in a crystalline form by passing the vapor of osmic acid over red-hot charcoal. The crystals apparently belong to the first or regular system, and are hard enough to scratch glass. The color is grayish-blue, becom-

ing even violet when the light is reflected several times upon the surface of the metal.—6 *B*, *May* 8, 1876.

CONVERSION OF BRUCINE INTO STRYCHNINE.

Sonnenschein has shown that brucine may be converted into strychnine by the action of nitric acid, and calls attention to the fact that this discovery may be of practical interest in toxicological investigations, since brucine might be converted into strychnine in course of the examination.—35 *C*, 1875, IV., 212.

OLEANDRINE.

It has long been known that oleander leaves contain an active poison, which was first examined by Lukowski in 1861. This body, oleandrine, has lately been reinvestigated by Bettelli, who obtained it in an imperfectly crystalline condition. It is pale yellow, soluble in water, alcohol, ether, chloroform, fusel-oil, and olive-oil. At 56° C. it softens, becomes a greenish liquid at about 70°, and at 170° it undergoes partial decomposition. Bettelli also succeeded in forming the chlorhydrate of the alkaloid.—35 *C*, *September* 27.

BISULPHIDE OF CARBON AS AN ANTISEPTIC.

Hugo Schiff calls attention to the remarkable antiseptic properties of carbon disulphide. A dissected frog, which had served for physiological experiments, was sealed up in a glass vessel, with a few cubic centimeters of the antiseptic, as long ago as 1869; the specimen as yet shows no trace of putrefaction. A similar trial with the entrails of poultry, and another with a small lizard, have resulted likewise. Two hundred grammes of beef, treated with bisulphide, remained for months unaltered; and then, after cooking, was readily eaten by a dog.—35 *C*, IX., 828.

MANUFACTURE OF CARBOLIC ACID.

The following process for separating carbolic acid from the cresylic and other liquid tar acids was recently patented by Lowe and Gill in England. The partially or wholly hydrated mixtures of tar acids are submitted for a sufficiently prolonged time to a temperature varying between 15° and 56° Fahr. The carbolic acid crystals thus formed are sepa-

rated from the mother liquors containing the liquid tar acid and a residue of carbolic acid dissolved in them. Complete purification of the carbolic-acid crystals thus obtained is effected by recrystallization, either by partial fusion or solution in water, with subsequent refrigeration. Carbolic acid of high degrees of purity is obtained by dehydrating these carbolic-acid crystals.—*Practical Magazine, Dec.*, 1874, 437.

DETECTING ADULTERATIONS IN COFFEE.

Wittstein, in a paper published in "Dingler's Polytechnic Journal," gives a detailed method for testing coffee, which is treated in a great variety of ways for the purpose of imparting greater strength or weight, a better color, or some other desired quality. He remarks that roasting, and still more grinding, coffee renders it almost impossible to apply the necessary tests. The principal vegetable substances used in adulterating coffee are chicory, beet-root, carrot, figs, corn, malt, etc. A simple method of testing coffee for a mixture of chicory is to shake it with water; if pure it remains floating for an hour together, whereas chicory sinks. An infusion of burned chicory, diluted with much water and treated with potassium bichromate, undergoes no visible change; but coffee assumes a deep brown tint, causing a resemblance to porter. This is only observed, however, where the substance is either entirely coffee or entirely chicory. To detect a mixture of the two, the decoction is diluted with eight times its bulk of water, filtered, and the dilution increased to twelve parts. If the decoction contains pure coffee, on adding to thirty drops of it two drops of concentrated hydrochloric acid, boiling for a few seconds, then adding fifteen drops of a solution of one part of potassium ferrocyanide in eight parts of water, and boiling as before, the solution becomes first green, then dark green. Six drops of potash are next added, and the whole is boiled for two minutes, the solution becoming first brown and then clear pale yellow, with a slight dirty-yellow precipitate. With chicory alone, the solution finally remains brown and turbid, and after long standing a precipitate falls, the supernatant fluid retaining its brown color. With a mixture of twenty-four drops of coffee and six of the chicory decoction, a final brown turbid solution is obtained. A decoction of coffee of average strength contains

one per cent., and of great strength barely two per cent., of the dry soluble matter. The evaporation residue consists of a deep brown, shining, varnish-like mass, feeling quite dry to the touch after two days. If the ordinary substitutes are present, however, this residue becomes sticky after one or two hours' standing, and quite damp in twenty-four hours.

ON THE GASES INCLOSED IN COAL.

An examination of the gaseous substances contained in coal, and also of the gases which are evolved from fissures in coal-mines, has been made by Thomas. The coals which he examined were of three sorts: the bituminous or house coals, the semi-bituminous or steam coals, and the anthracite coals. The samples examined all came from the South Wales coal-basin. In obtaining the gas from the coal, slices were first sawn from the middle of large cubical blocks, and a strip cut from the centre of each of these six or eight inches long, and five eighths of an inch square. This was then placed in a hard glass tube, connected with a mercury pump, and exhausted. Very little gas, however, was obtained in this way—only two or three cubic centimeters in 100 grammes of coal. On placing the tube in boiling water, the exhaustion being continued, gas was freely evolved. When it ceased, the temperature was raised to 200° and even 300° Centigrade, whereby additional quantities of gas were obtained. On analyzing the gas, it was found to be composed of marsh gas, carbon dioxide, nitrogen, and oxygen. The bituminous coals give the minimum amount of gas, but the quantity of carbon dioxide contained in it is large. Steam coals come next, as much as eighty-seven per cent. of the gas obtained from them being methyl hydride, or marsh gas. Anthracite coals give more gas than the others, one specimen giving 600 cubic centimeters of gas from 100 grammes of coal when heated to 100°. But at 200°, 1000 c. c. were given off, and at 300°, 1875 c. c. In composition, the gas from anthracite closely resembles that from steam coal. The examination of the gas collected from fissures in the mine, as well as that obtained by boring the blocks of coal, was almost pure marsh gas, the amount present rising sometimes even to 97.65 per cent.—21 *A*, II., xiii., *September*, 1875.

SCHÖNBEIN'S TEST FOR NITRATES.

Storer has explained at length the reaction proposed by Schönbein for the detection of minute traces of nitrates. Two modes of applying the test were originally given. In the one, dilute sulphuric acid and iodo-starch paste were added directly to the nitrate solution, and the mixture was stirred with a zinc rod. In the other and better mode, the nitrate was first reduced by means of zinc or cadmium, and then the solution was acidulated with sulphuric acid and the iodo-starch paste added. He finds, contrary to the opinion of Carius, that no objection seems to lie against this test on the score of delicacy; but that it has a fatal defect in the forms in which it is commonly used, in that mere water, entirely free from any nitrates or nitrites, will, on being treated with zinc or cadmium as in the process of testing, react upon iodo-starch as if these compounds were present. This coloration, thus produced, the author shows is due to the hydrogen peroxide which is formed by the action of the metal itself upon the water — a reaction observed by Schönbein himself. Hence, whenever the degree of coloration of the iodo-starch obtained in testing for a nitrate by this method is less intense than the tint obtainable from 0.000187 gramme of potassium nitrate in 50 cubic centimeters of water, it is difficult to decide whether the coloration may not be wholly due to hydrogen peroxide. Having thus shown the defect, the author set himself at work to remedy it, and to devise a modification of the process which, while preserving the delicacy of the test, should yet be easily applied. The very simple plan was adopted of acidulating the solution very slightly, before boiling the nitrate in it, with metallic cadmium. Under these circumstances no hydrogen peroxide is produced, while the reduction of the nitrates goes on quite as well. The only precaution necessary is to prevent the loss of any of the nitrous acid, which is easily accomplished by attaching to the flask a small inverted Liebig condenser during the boiling. In his experiments, 0.0001 gramme of nitrogen pentoxide, placed in the solution as potassium nitrate, in 50 c. c. of water containing two drops of dilute sulphuric acid, gave, after boiling for five minutes, a reaction in less than fifteen minutes. Even 0.00005 gramme gave the reaction in

the course of half an hour. Zinc, amalgamated zinc, aluminum, iron, lead, and magnesium were also used as reducing agents, but none of them acted as efficiently as cadmium. No experiments were made with the alkali metals.—4 *D*, III., xii., *September*, 1876, 176.

HYDROCELLULOSE.

In some of the processes in the arts in which woody fibre is used, as in paper-making, for example, the fibre appears to undergo during the process of manufacture a peculiar transformation, by which it is rendered friable. Aimé Girard has investigated the matter, and finds that this change is owing to the assumption of a molecule of water by each molecule of the cellulose, thus producing a new body having the composition $C_{12}H_{22}O_{11}$, to which he gives the name of hydrocellulose. To prepare it some form of purified cellulose, such as carded cotton, is placed in sulphuric acid of 45° Baumé in the cold for twelve hours. It is then well washed, pressed, and dried. After it is dry, its fibrous character is destroyed by pressure; rubbing between the fingers converts it into a white powder. Girard supposes that this substance may be formed in the process of bleaching paper-pulp by chloride of lime; and accounts in this way for the peculiar brittleness of certain papers found in commerce.—6 *B*, LXXXI., *December*, 1875, 1105.

A NEW OXIDE OF SULPHUR.

Weber has investigated the cause of the intense blue color which is developed whenever sulphur is allowed to act upon sulphuric oxide or disulphuric acid, and has shown that it is due to an oxide of sulphur hitherto unknown, which he has succeeded in isolating and examining. To prepare it, carefully dried flowers of sulphur are thrown in small portions at a time into sulphuric oxide containing sulphuric acid. At the instant of contact, the sulphur is converted into dark blue liquid drops which sink to the bottom of the liquid and there solidify. Care should be taken to keep the temperature at 15° Centigrade, since below this point the whole liquid solidifies, and above it the blue body decomposes. After the operation the excess of liquid is poured off, the blue crystalline crusts are drained, and the excess of sulphuric oxide driven

off at a temperature not exceeding a blood heat. Bluish-green crusts are thus obtained which are very friable, and which have a structure similar to malachite. They decompose without fusion slowly at ordinary temperatures, more rapidly on heating, evolving sulphurous oxide, and leaving sulphur behind. In a cool place the decomposition is so slow that the substance may readily be weighed for analysis. Moist air decomposes it rapidly, and it hisses when thrown into water. Alcohol and ether also decompose it and set free sulphur. A mean of five closely accordant analyses showed that it contained 57.12 per cent. of sulphur, thus giving it the formula S_2O_3. The author names it sulphur sesquioxide, or dithionic oxide. No compounds of it have yet been made. Selenium gives an analogous compound, having the formula $SeSO_3$. It is dirty green in mass, but is yellow when in powder.—*Poggendorff's Annalen*, CLVI., *December*, 1875, 531.

CORROSION OF PLATINUM STILLS BY SULPHURIC ACID.

Scheurer-Kestner having communicated to Hofmann, in 1862, certain results which he had obtained in the process of concentrating sulphuric acid in platinum stills (which results were published by the latter in his Report on Chemical Industry), and these results having been since that time called in question, the author has examined the facts in the case still more fully, and now publishes a new set of observations. From 1851 to 1861, 4309 tons of sulphuric acid were concentrated to 66° Baumé, in an alembic the body of which weighed 40 kilogrammes. The entire loss of this part of the still during this time was 12,295 grammes, being 2.859 grammes for each ton of acid worked. Perceiving that the cause of this large loss in platinum was the presence of nitrous products, ammonium sulphate was added to the acid in amount just sufficient to destroy them. In 1862, 1843 tons of acid were concentrated in the still, with a loss of 2490 grammes, being only 1.22 grammes of platinum for each ton of acid, a marked decrease. From 1864 to 1875, 17,516 tons (of 1000 kilogrammes each) were concentrated to 66° in a still the body of which weighed 50 kilogrammes. The acid contained sulphurous acid, but no nitrous compounds. The loss of the still was 16,178 grammes, or 0.925 gramme to the

ton of acid. It may be assumed, therefore, that to produce an acid of 66° Baumé (containing 94 per cent. of real acid), there is a loss to the still per ton of acid of one gramme when nitrous compounds are absent, and of 2½ to 3 grammes when they are present. If, however, the concentration be carried above 66°, these numbers are much increased. In a still weighing 30 kilogrammes, 180 tons of acid, containing 97 to 98 per cent. of real acid, were produced. The still lost 1092 grammes of platinum, or 6.07 grammes per ton of acid. In producing 47½ tons of acid of 99½ per cent., there was a loss of 8.8 grammes of platinum per ton of acid, and an analysis of the acid showed that it contained 8.38 grammes of platinum to the ton, present in it in solution, thus proving the loss to be a chemical one. To the figures here given for the loss of the body of the retort, about 13 per cent. should be added for the loss of the other parts. The use of a platinum-iridium alloy for the stills prevents to a large extent this action, but the brittleness and consequent fragility of the alloy is a serious objection to it.—*Bull. Soc. Ch.*, II., xxiv., *Dec.*, 1875, 501.

NON-OXIDATION OF CARBONIC OXIDE BY OZONE.

The question of valency among the elements is a fundamental one in chemistry; and while all chemists are agreed that a given atom may form a series of compounds with the same substance, they are divided on the question of the interpretation of this phenomenon. On the one hand, it is claimed that the valence of an atom is fixed and invariable, and consequently all but one of its compounds, and that the highest, must be unsaturated. On the other, it is asserted that the valence is variable, and that by twos, and consequently that in the lower of two compounds formed by an element it is as fully saturated as in the higher. Carbonic oxide, for instance, whose molecule contains one carbon and one oxygen atom, has, according to the former view, two free bonds. But according to the latter it is saturated, though at a lower stage than in carbon dioxide. The weak point in the theory of variable valence is the law of, or the cause for, the variation. The constitution of carbonic oxide being thus in doubt, Remsen and Southworth have sought to throw some light upon it by acting upon it with ozone, a body

which is supposed to give up its extra oxygen atom with great readiness. For this purpose they passed the pure monoxide through potassium hydrate and lime-water into a flask. Into the same flask oxygen was passed after treatment with potassium hydrate and lime-water, and also after being ozonized. The interior of the flask was moistened. From the flask a third tube led the products first through lime-water and then over potassium hydrate. But, though the currents of gas were slow and the action was long continued, not a trace of dioxide was formed, even when the experiment was repeated in direct sunlight. This result is the more suprising from the readiness with which carbonic oxide is oxidized by chromic acid solution. The authors propose to study the action of hydrogen peroxide on this substance.—4 *D*, III., xi., *February*, 1876, 136.

ON THE HYDROCARBONS OF COAL GAS.

Berthelot has made a somewhat exhaustive investigation of the hydrocarbons existing in coal gas, the results of which go to confirm his theory of the action of acetylene and hydrogen at high temperatures. In the gas which is supplied to the city of Paris he finds that benzene may be detected very readily in so small a quantity as two or three cubic centimeters by exposing in it a drop of fuming nitric acid. On diluting the drop with water, the peculiar almond odor of nitrobenzene is at once recognized. If fifty liters of the gas be passed through 8 or 10 c. c. of the acid, enough nitrobenzene separates on dilution to weigh; and from the amount thus obtained it appears that this gas contained two or three volumes of benzene vapor in the hundred. More accurately, the amount present is from 3 to 3.5 volumes. Next to marsh gas, therefore, benzene is the principal hydrocarbon in coal gas, and is the substance to which the gas mainly owes its illuminating power. Besides benzene, the gas contains ethylene, propylene, and butylene of the olefine series, and acetylene, allylene, and crotonylene of the acetylene series. These bodies were detected by absorbing them with concentrated sulphuric acid, diluting, and then fractioning. In one million volumes of the Paris gas, the author concludes that there are by this analysis: Benzene in vapor, 30,000 to 35,000 volumes; acetylene, 1000 (about); ethylene, 1000 to 2000; propylene,

2.5; allylene, 8; butylene and analogues, traces; crotonylene, 31; terene, 12; hydrocarbons, transformed into fixed polymers, 83; diacetylene and analogous hydrocarbons, 15 (estimated). Berthelot believes that these products arise from certain fundamental reactions, already expressed in his pyrogenic theory, between the four fundamental hydrocarbons—acetylene, ethylene, dimethyl, and methane. Together with hydrogen, these bodies form a system in equilibrium such that at a red heat they are all formed from any one of them present at the start. If marsh gas or methane be taken, the olefine series is directly produced from it by the abstraction of hydrogen and polymerization. Acetylene produces benzene (which is only triacetylene) as well as the analogous polymeric series. The more complex bodies come from the more simple ones. Thus acetylene and benzene give styrolene; acetylene and styrolene, naphthalene; acetylene and naphthalene, acenaphtene; and benzene and styrolene, anthracene. Moreover at a dull red heat acetylene unites with ethylene to form ethylacetylene, and with propylene to yield propylacetylene, the former identical with crotonylene, the latter with terene. In the light of this research, it is obvious that the present method of determining by analysis the illuminating power of a gas, based as it is on the assumption that the chief illuminants are ethylene and acetylene, is worthless.—*Bull. Soc. Ch.*, II., xxvi., *August*, 1876, 104.

PHYSICAL ISOMERISM.

While observing the properties of a new compound discovered by him, called nitrometachlor-nitrobenzene, Laubenheimer has discovered the best example hitherto known of physical isomerism. The substance mentioned is prepared by metachlor-nitrobenzene with a mixture of fuming nitric acid and sulphuric acids, with the aid of heat. On pouring the whole into water a yellow oil falls down, which on cooling solidified almost completely to a crystalline mass. On investigation, it appears that this substance exists in four distinct modifications, three of which are solid and one liquid. Since, chemically, there can be but one body produced in the above treatment, it is obvious that the isomerism here is purely physical; a conclusion confirmed by the ready conversion of the four forms the one into the other. The first, or

α-modification, is obtained by dissolving the crude product in warm alcohol and allowing it to cool. At first an oil separates, in which after a time crystals appear, which may be developed into thick prisms on repeating the operation. These prisms are monoclinic twins, with a well-defined cleavage, having the plane of the optic axis perpendicular to the plane of symmetry. They show strong negative double refraction, and fuse at 36.3° Centigrade. Any of the other forms when melted crystallize in this form on touching the liquid with a crystal fragment of it. The second, or β-modification, is obtained by fusing the former completely at 39° to 40°, and allowing to cool. Long concentric groups of prisms are formed, which are monoclinic, but which are without cleavage, have a different axis ratio and axis angle, and fuse at 37.1°. Crystals of α after five weeks yield β on crystallization from alcohol. The third, or γ-modification, crystallized out of the aqueous solution into which the mixture was poured in preparing the substance. It is also the most permanent form of all, both α and β being converted into it in a few weeks, though becoming turbid in twenty-four hours. The crystals are orthorhombic, show a distinct cleavage, and have a moderate but positive double refraction. They fuse at 38.8°. The liquid modification is obtained whenever either of the solid forms is heated to 42°. On cooling it remains permanently liquid. In accounting for this physical isomerism, Laubenheimer assumes Naumann's hypothesis that physical molecules are formed by the aggregation of chemical molecules, and believes that the larger the number of chemical molecules the more stable the body. The fusing-point of the body containing the less complex physical molecule is therefore lower, the specific gravity is less, and specific heat is greater.—35 *C*, IX., *June*, 1876, 760.

THERMO-CHEMISTRY OF OZONE.

Berthelot has studied thermo-chemically the formation of ozone. Pure and dry oxygen was passed through a tube where it was subjected to the influence of the silent electric discharge, and then into a calorimetric flask containing 500 cubic centimeters of a solution of arsenous acid in hydrochloric acid, previously graduated. At the end of twenty to thirty minutes, six to nine liters of oxygen had passed through

the calorimeter, and its temperature had been raised one third of a degree. By passing the oxygen current alone through the apparatus under the same conditions for an equal time, both before and after the experiment, the thermal data were rendered complete. The arsenic solution was treated with a graduated solution of potassium permanganate in excess, and then titered back with a standard solution of oxalic acid. In this way the amount of arsenous acid oxidized, and consequently the amount of ozone absorbed, was determined. In two experiments, the oxygen absorbed was 30.3 and 51.9 milligrammes, corresponding to 90.9 and 155.7 milligrammes of ozone; the heat set free being 118.2 and 223.7 calories respectively. Whence for one molecule, 48 grammes, the heat is equal to +68.8 calories. Subtracting from this the heat produced in the oxidation of a molecule of arsenous acid, determined by Favre and by Thomsen to be +39.2 calories, we have +29.6 calories for the heat set free by the conversion of one molecule of ozone into oxygen, and of course −29.6 calories in the reverse process. This value is one half greater than that given in the formation of the same volume of nitrogen monoxide or of chlorine monoxide, in both of which the value is −18. It is even two thirds of that given in the formation of nitrogen dioxide, 43.3. In the three cases of direct synthesis of compound gases by the electric spark, ozone, nitrogen tetroxide, and acetylene, the heat values are all negative, being −29.6, −24.3, and −64 respectively; an obvious proof of the function of electricity in chemical synthesis. Ozone is therefore a body in whose formation heat is absorbed, and whose activity is due consequently to this heat, which when it combines is again set free. It is a magazine of energy stored up under the influence of electricity. This fact is the more remarkable when it is remembered that ozone is condensed oxygen, and that condensation sets free heat.—6 *B*, LXXXII., *June*, 1876, 1281.

MEDICO-LEGAL EXAMINATION FOR ARSENIC.

In a series of researches undertaken for the purpose of determining certain physiological questions (and in the course of which it was discovered that arsenic showed a special tendency to localize itself in the nervous tissues, especially in the brain and spinal cord), Gautier was led to suspect the

quantitative accuracy of the methods for the separation of arsenic from the tissues which are ordinarily made use of, and to devise an improved method of his own. The improvement has reference in the first place to the separation of the arsenic from the organic matter, and in the second to obtaining it in a weighable form. For the former, 100 grammes of the finely divided animal matter is placed in a porcelain capsule with 30 grammes of pure nitric acid, and moderately heated. The mass at first liquefies, and then thickens and becomes orange-colored. The capsule is taken from the fire and 5 grammes of pure sulphuric acid are added. Heat is applied till white fumes appear, 10 or 12 grammes of nitric acid are allowed to flow drop by drop on the residue, and the whole is heated to carbonization. An easily pulverizable mass is thus obtained, which is exhausted with boiling water, filtered, the filtrate reduced with a few drops of hydro-sodium sulphite, and precipitated as usual with hydrogen sulphide. The improvement in the determination consists in passing the gas evolved from a Marsh apparatus through a tared glass tube heated to redness by charcoal for a length of 20 to 25 centimeters. After the arsenic is all carried over, the tube is detached and again weighed. The difference is the amount of arsenic, the results being accurate. Five milligrammes of arsenous oxide mixed with 100 grammes of muscular tissue gave when treated by this process rings weighing respectively 3.72 and 3.67 milligrammes; the theoretical quantity being 3.79.—*Bull. Soc. Ch.*, II., xxiv., *October*, 1875, 250.

E. MINERALOGY AND GEOLOGY.

THERMO-ELECTRIC PROPERTIES OF MINERALS.

An interesting series of experiments has been carried on by Hankel upon the thermo-electrical properties of some mineral species. It is a familiar fact that crystals of tourmaline when subjected to a decided change of temperature develop electricity, and those crystals which are differently formed at the two extremities show at one end positive and at the other negative electricity. Crystals of other species, as, for instance, topaz, which do not possess this hemimorphic character, act differently when subjected to the same conditions, as shown by Hankel. The electricity which is developed at both extremities of the same axis is alike—for instance, positive—while the opposite or negative electricity is shown at both extremities of another axis. The investigations just made public have special reference to several species whose crystals are developed alike in the direction of all lateral axes, but this development is different from that in the vertical direction. For example, crystals of apophyllite, when subjected to sudden cooling, develop at the extremities of the vertical axis positive electricity, while laterally—that is, in all the planes of the prisms—the electricity is negative. Also crystals of vesuvianite (idocrase) show similar relations, the terminal plane and the pyramidal plane have one character, positive; while the prismatic planes, corresponding to the lateral axes, are negative. Crystals of emerald and beryl have not a very decided electrical character, but here also it is true that the end planes have one electrical character and the lateral planes another.

It may be added that in other species, as, for instance, prehnite, Hankel has found a large number of positive and negative electrical poles distributed over the surface of a crystal.

MINUTE WORK IN MINERALOGY.

As an example of minute work in mineralogy, it may be interesting to note the recent investigations of Baumhauer

upon the etchings which may be produced on the crystalline faces of many mineral species. Thus on crystals of calcite minute triangular depressions may be produced by subjecting them to the working of dilute hydrocholoric acid; crystals of salt exposed to moist air for a little time show depressions which have the form of a four-sided pyramid. Hydrofluoric acid, also, will in a few moments produce distinct though microscopic etchings on a thin plate of ordinary potash-mica, while a corresponding result is obtained by treating crystals of garnets with caustic alkalies. The interest of these and similar experiments is that they give us an insight, as nothing else can, into the molecular structure of the crystals, or, in other words, the way they have been built up. Some authors have even maintained that the form of the etchings produced must be that of the fundamental molecules, and, though this may not be sustained, the relation that subsists must certainly be a close one.

MINERAL STATISTICS OF THE COLONY OF VICTORIA.

From a report upon the mineral statistics of the colony of Victoria for the year 1874, which has lately been presented to Parliament, we glean the following facts: The amount of gold raised in the colony in 1871 was 1,290,844 ounces; in 1872, 1,218,094 ounces; in 1873, 1,162,492 ounces; and in 1874, 1,105,115 ounces. The value of the machinery and appliances used on the gold-fields in 1874 was £2,078,936 (or something over $10,000,000), the total area of the auriferous district worked upon was 1063 square miles, and the number of distinct quartz reefs was 3398. One hundred and eighty tons of silver ore were raised during the year, from which 11,906 ounces of silver were extracted.

DAUBREITE.

The new mineral *Daubreite*, from the bismuth mine of Cerro de Tazna, in Bolivia, has lately been described by Domeyko. It occurs in yellowish or grayish earthy masses, in which occur many crystalline lamellæ of a pearly lustre, and opaque. Specific gravity about 6.5. In composition it is an oxychloride of bismuth.—6 *B*, *April*, 1876, 922.

GARNIERITE AND NOUMEITE.

Garnierite and *Noumeite* are two new nickel minerals found near the town of Noumea, in New Caledonia, and described by Professor Liversidge, of Sydney. They are very similar to each other in appearance, though they are considered to have some distinguishing characters. They are amorphous, of a bright apple-green color, and so soft as to be easily polished by rubbing with the thumb-nail. The economic importance of these minerals lies in the fact that they contain about twenty-five per cent. of nickel-oxide, which, as they occur in large quantities, makes them valuable as nickel ores. They both occur filling veins and fissures in serpentine.

SIDERAZOT, A NEW MINERAL.

Professor Silvestri, of Turin, proposes the name *siderazot* for a native iron nitride or compound of iron and nitrogen which he has detected among the fumarole products of Mount Ætna. The eruption of August, 1874, was especially interesting in that, while commencing violently, the duration was short, and the end came suddenly. It was at this time that the new mineral was found, appearing as a thin incrustation, of gray metallic lustre, coating the lava. It contained chemically ninety-one per cent. of iron and nine per cent. of nitrogen. The author makes some remarks upon the possible method of formation of this rare compound, but the matter seems to be yet involved in much uncertainty.

FRIEDELITE.

Friedelite is a hydrated silicate of manganese, discovered by Bertrand at the mine of Adervielle, valley of Louron, in the Pyrenees. It occurs in crystalline masses of a carmine red color, with a specific gravity of 3.07. It crystallizes in the rhombohedral system, and possesses in a high degree the property of doubly refracting light.—6 *B*, *May* 15, 1876.

KAOLIN IN NEBRASKA.

It has lately been reported that a deposit of kaolin, of not less than thirty feet in thickness, and underlying about 100 acres, has been discovered in the neighborhood of Omaha.

It appears that the deposit crops out along a bluff for over half a mile, with but a few inches of earth covering it. The character of the material is said to improve with the depth, the upper portions being coarse and granular in texture, while lower down it becomes progressively finer and whiter. It is represented to be remarkably free from foreign impurities, and adapted for the manufacture of a great variety of articles in large demand in the Western country. There is a railroad, and an abundance of timber and water in the neighborhood.—6 *D*, 32, 212.

TWO NEW MINERALS, MELANOPHLOGITE AND ÆRINITE.

Two new minerals have been announced by Professor Von Lasaulx, of Breslau. The complete descriptions have yet to be given. One of these minerals is called *melanophlogite*, the name having reference to what is regarded as one of its distinctive characters, that of turning black upon ignition. It occurs in minute cubes upon sulphur from Girgenti, in Sicily. Sometimes a thin incrustation of quartz covers the crystals of sulphur, and upon this rests the new mineral. Its chemical composition is still uncertain, but it is supposed to be a hydrated silica. The material examined contained also some iron and lime, but probably only as impurities.

The second new mineral referred to has received the name *ærinite*. It is an essentially iron silicate, and occurs in masses with a scaly structure. Its only decided character is its blue color, to which it owes its name. The locality is uncertain, though the specimen examined purported to be "from Spain."

MEXICAN ONYX.

This beautiful stone, so much admired in the Mexican exhibit at the Centennial Exposition, has been analyzed by Damour. It is a mixture of the carbonates of lime, magnesia, iron, and manganese, containing about 89.5 per cent. of the one first named. Specific gravity, 2.77.—35 *C*, IX., 848.

NEW VANADIUM MINERALS.

Roscoelite, described recently by Dr. F. A. Genth, is a brownish micaceous mineral from California. Its chief constituents are vanadic acid (about 20 per cent.), silica, alumina, and potash.

Psittacinite, also analyzed by Genth, is from the Iron Rod Mine, Silver Star District, Montana. It had previously been mentioned as supposably a tellurate of lead and copper. Now, upon actual analysis, it proves to be, not a tellurate, but a hydrous vanadate of the above-named metals, containing some 19 per cent. of vanadic acid. It occurs in very thin, cryptocrystalline coatings, varying in color from siskin to olive green.—1 *A, August* 25.

THE BORAX LAKE OF CALIFORNIA.

It appears that the incredulity with which statements concerning the borax lake have been received in England has been considerably lessened by supplies of the material coming to the London market. The pottery districts are especially interested in the discovery. Accounts set forth that very extensive works are now nearly completed for the refining and purifying of this borax for shipment. Stimulated by the action of the railroad company, the borax company has put up large works, and expects to turn out from twenty to fifty tons of the mineral per day. The deposit of borax extends over an area of eighteen miles in length by six to eight miles in width, covered with crude borax to the depth of three to five feet. The crude mineral averages from twenty to forty per cent. of the pure salt.—*American Exchange and Review, June*, 1875.

ACHREMATITE.

A new mineral, bearing the title of *Achrematite*, has been described by Professor Mallet, of the University of Virginia. It came into his possession labeled "Silver ore from the mine of Guanaceré, state of Chihuahua, near the Durango line," and, indeed, resembled one of the haloid compounds of silver. Analysis, however, showed it to be a molybdo-arsenate of lead, intermixed with finely divided ferric hydrate. —21 *A, November*, 1875.

NEW MINERALS.

Scacchi, in studying the mineral products of the eruption of Vesuvius of April, 1872, has described quite a number of new species. Most of these seem to be saline bodies; one is simply hydrofluoric acid, and is named hydrofluorite;

another, proidonite, is fluoride of silicon. Atelite is a hydrated oxychloride of copper; cryptohalite consists of ammonium silicofluoride; chloraluminite is aluminic chloride. Chlorothionite contains copper, potassium, chlorine, and sulphuric acid; pseudocotunnite is a double compound of the chlorides of potassium and lead. Other species described by Scacchi are chlorocalcite, erythrosiderite, chloromagnesite, cupromagnesite, and microsommite. Associated with all these were the previously known minerals hematite, magnetite, tenorite, sylvite, halite, sal ammoniac, molisite, aphthitalite, anhydrite, pyroxene, byssolite, chrysolite, and apatite.—4 *D*, *December*, 1875.

DREDGING FOR AMBER.

According to an official report from Memel, Germany, an establishment has been organized for gaining amber by dredging for it in the Kurische Haff, near the village of Schwarzorts, situated about twelve miles south of Memel. It has been known for many years that amber existed in the soil of this place, from the fact that the dredger employed by the government for the purpose of clearing away the shallow spots near Schwarzorts which impeded navigation brought up pieces of amber, which were duly appropriated by the workmen, and at the time no particular attention was paid to the matter. Some time afterward, however, some speculators associated, and made an offer to the government not only to do the dredging wherever required at their own expense, but to pay a daily rent, provided the amber which they might find should become their property. This proposal was accepted, and the rent fixed at fifteen thalers, and later at twenty-five thalers, for each working day. The dredging was begun with four machines worked by men and one by horses. Judging from the extended business transactions in this matter, its results must have been extremely profitable. At present the work is carried on with eighteen steam-dredges and two tug-boats, the whole managed by about 1000 laborers.—*March* 5, 1875, 170.

INTERESTING IRON METEORITE.

The iron meteorite from Rittersgrau, Saxony, which fell in the year 1833, has recently been described. The weight of

the piece, which belongs to the School of Mines at Freiburg, is 173 pounds. It has recently been cut in two by the operation of fourteen steel saws, the cutting occupying two complete months; the smaller of the two portions thus obtained, weighing about forty-eight pounds, has been subjected to chemical and other experiments. The area of the section thus laid bare was about 100 square inches. Some small pieces have been sold at such prices as to warrant the statement that the entire mass, at the same rate of prices, should be valued at about $5000. The suggestion is plausible that the three meteors found at Rittersgrau, Steinbach, and Reitenbach belong to one and the same meteor which fell in the year 1164.

AN INTERESTING AEROLITE.

In meteoric astronomy, a very suggestive note has been published by J. Lawrence Smith. He states that the mass of meteoric iron which fell on the 1st of August, 1835, near Charlotte, Dixon County, Tenn., is one of exceeding interest, as it is one of four cases of the fall of masses of iron free from earthy matter. The meteor itself has been preserved in the cabinet of Professor Troost for the past forty years. The meteorite displays the Widmannstättian figures with exquisite beauty, and also the marks to which Mr. Smith some time ago gave the name of Laphamite figures. The gases contained in this iron have been examined by Professor Wright, who attributes to it seventy-one per cent. of hydrogen, fifteen per cent. of carbonic oxide, and thirteen per cent. of carbonic acid. The meteorite does not appear to have been heated in the atmosphere to a sufficient degree of intensity to fuse the surface. On the whole, the specimen referred to is the most interesting piece of meteoric iron yet known.—4 *D*, X., 349.

BORING FOR COAL.

Siegert gives the details of a deep bore made at Chemnitz in search of coal. Many previous attempts had been made even at Chemnitz to develop coal strata. The present attempt was made with a diamond borer, and was begun on the 4th of November, 1874, and progressed at the rate of 2.85 meters per day. The cores as taken from the borer

have been preserved in the School of Mines. The depth to which the bore was extended was 210 meters, of which the first thirty-five were porphyritic stone, and the latter 175 a red-colored sandstone and conglomerate, and not a trace of coal was found, or is to be expected. Observations of the temperature at various depths seem not to have been undertaken.—*5th Ber. Nat. Gesells., Chemnitz*, 1875, 244.

COAL-FIELDS OF SPAIN.

In a paper lately read before the French Society of Engineers, the area of the coal-fields of Spain was estimated to equal 150,000 hectares (the hectare equals 1.47 acres). From these deposits only about 500,000 to 600,000 tons of mineral are annually produced, while in Belgium, with the same area, the production is 10,000,000 tons. The Spanish coal-fields are in the provinces of Castile, Leon, and the Asturias. The process of extraction is described as being quite rude and imperfect.—17 *D*, XX., 56.

SECTIONS OF COAL.

Dr. C. Johnson gives the following as the method adopted by him in preparing sections of coal: 1. Macerate suitable pieces one quarter or one half inch thick in liquor potassæ until they swell or soften. 2. Soak for a few hours in pure water, and drain. 3. Macerate in nitric acid until the color changes from black to brown. 4. Soak for a few hours in water, and drain. 5. Put in alcohol for a few days. 6. Fasten in a cutter with paraffin, and make sections, the sections to be mounted in balsam after successive immersions in absolute alcohol and oil of cloves.—*Medical News, Cincinnati, July*, 1875.

COMPOSITION OF CORAL.

The composition of coral has been carefully investigated by Professor Dana. Ordinary corals have a hardness a little above that of common limestone or marble, giving out a ringing sound when struck with a hammer. This may be owing, he considers, to the carbonate of lime being in the state of aragonite. It is a common mistake to suppose that coral, when first taken from its watery bed, is soft, and hardens through exposure. The live coral may feel somewhat

slimy in the fingers, but if the animal matter be washed away it is found quite hard. Chemically the chief constituent of the whole is carbonate of lime, in the proportion of ninety-five to ninety-eight parts in one hundred, with one and a half to four parts of organic matter, and some earthy ingredients, such as phosphate of lime, with a trace of silica, amounting usually to less than one per cent. Forchhammer found 2.1 per cent. of magnesia in Corallium rubrum, and 6.36 in Isishippuris. The sources of these constituents are the sea-water and the ordinary food of the polyps, the process of absorption, assimilation, and secretion going on in them as in all animal organizations.—*Engineer*, XL., 1034, 281.

VOLCANIC DUST.

A microscopic examination of the dust which fell in parts of Sweden and Norway on the night of March 29–30, 1871, has led M. Daubrée to believe that it proceeded from a volcanic eruption in Iceland. The dust was found to be composed of fragmentary transparent grains, some colorless, others more or less brownish-yellow. Minute crystals of feldspar and pyroxene were recognized.—*Academy, May* 8, 1876.

VOLCANIC HISTORY OF IRELAND.

In the annual address delivered before the Royal Geological Society of Dublin, Professor Hull has given an interesting account of the volcanic history of Ireland. He shows that in the Lower Silurian there are numerous examples of volcanic rocks in several parts of the island; thus in the counties of Wicklow and Waterford there are numerous sheets of felstones and porphyries accompanied by beds of ash and volcanic breccia, and similar conditions in other districts. All of these volcanic rocks are to be regarded as having been erupted from vents sporadically breaking out over the sea-bed of the period, they having been in turn covered up by fresh sediments. In the Upper Silurian there is little evidence of volcanic action; in the Devonian there are more, and in the Carboniferous they are still more decided. Coming down in the geological history, it is necessary to pass over to the Tertiary before the products of the volcanic fires are again met with. In this period they were

very active, and the area now occupied by the volcanic rocks in the northeastern part of Ireland may be estimated at 2300 square miles, extending moreover to the west coast of Scotland. These last volcanic eruptions are some of the most extensive that the world has ever known, and it is to them that are to be referred the strange beauties of the Giant's Causeway and Fingal's Cave.

ELEVATION OF THE PACIFIC COAST OF SOUTH AMERICA IN RECENT TIMES.

Mr. Alexander Agassiz, in his recent trip to Peru, found occasion to conclude that the Pacific, within a comparatively recent time, extended through gaps in the Coast Range, and made an internal sea which stood at a height of not less than 2900 feet, and probably much above this. This is proved by the fact of the occurrence of coral limestone 2900 or 3000 feet above the sea-level, about twenty miles in a straight line from the Pacific. There are now no coral reefs on the west South American coast south of Cape Blanco, near the equator, owing probably to the cold oceanic currents; and this generalization in regard to the previous relations of land and water is one of very great interest. The corals referred to are of modern aspect, although the species are undescribed. The fact that there are extensive saline basins at a height of even 7000 feet on the coast of Peru would seem to indicate that the submergence was at one time still greater than that suggested. Indeed, eight species of *Allorchestes*, a salt-water genus of amphipod crustaceans found in Lake Titicaca, would seem to indicate that this lake, 12,500 feet above the sea, must have been at one time at the sea-level.—4 *D*, p. 499.

THE GLACIAL EPOCH IN THE ROCKY MOUNTAINS.

In reference to the glacial phenomena still to be traced in the Rocky Mountains, Professor Powell, in his recently published report on the geology of the eastern portion of the Uinta Mountains, states that there has been glacial action in the Uinta Mountains. There are found undoubted morainal deposits. The deep valleys that lie at the foot of the axial peaks of this great range have been beds of extinct glaciers. Morainal deposits and glacial grooves are found in very

many of these valleys. Often the valleys are so choked with the materials thus accumulated by the action of ice that it is with great difficulty one travels across them. The evidences of the glacial epoch are abundant, but they are found only high up on the Uinta Range, and the gravels and boulders of the low land are testimony only to the ordinary action of drift agencies. The gravel beds on the low lands are true drift.—*Powell's Report of* 1876, p. 171.

SUB-ALPINE LAKE BASINS DUE TO GLACIAL EROSION.

M. Istaldi, in discussing the subject of the glaciers of the Pliocene epoch which have been studied by Desor in Switzerland, shows, (1) That the existence of the sub-alpine lacustrian basins is intimately connected with that of the glaciers at the epoch of their greatest extension; that, in fact, the Alpine valleys and the Apennine valleys, and the basins of the lakes of Northern Italy, are all basins of erosion; that, (2) On the other hand, the thirty valleys which pour their waters into the great basin of the Po open into only six moraine amphitheatres. (3) All sub-alpine lakes are situated within these six amphitheatres, which are the work of the ancient glaciers. (4) There is no moraine amphitheatre without lakes. (5) There is no trace of lakes beyond the limits of these amphitheatres. (6) The breadth and length of the lakes are proportional to the dimensions of the moraine amphitheatre, which is itself in proportion to the dimensions of the zone of sedimentary earth. He concludes, therefore, that if the glacier period had not taken place, there would have been no sub-alpine lakes. An examination of the physical conditions of the Pliocene, and the fauna which they contain, shows that the climate was at this epoch warmer and dryer than to-day.—*Atti della Roy. Acad. della Scienza, Turin*, 1875, X., 490.

THE DEPOSITION OF FINE SEDIMENTS.

Dr. T. Sterry Hunt states, in reference to the question of the deposition of fine mud in the Mississippi, that the deposited matter requires from ten to fourteen days to subside; but that if sea-water or salt or sulphuric acid be added to the turbid water it becomes clear in from twelve to eighteen hours. Thus is explained the rapid precipitation that occurs

when the river-water mixes with the salt waters of the Gulf of Mexico. The cohesion of water diminishes when it holds saline matter in solution, as was said by Guthrie and was verified by Dr. Hunt. He found that the addition of eight parts of chloride of calcium to 1000 parts of water reduces the size of drops to one ninth, and the precipitation of suspended clay is made very rapid when a strong solution of salt is employed.—12 *A*, X., 277.

FORMATION OF FLOOD-MARKS AND GRAVEL BANKS.

In a communication on the high flood-marks on the banks of the River Tweed, made by D. M. House to the Royal Society of Edinburgh, the author maintains that when the sea stood at higher levels, all the rivers of the country must have likewise flowed in channels of higher levels, and that the flood-marks in question were formed during that condition of affairs, and not when the rivers were flowing in their existing channels. With reference to the formation of ridges of drift deposits, the author maintains that they were not due to ice or to river action proper, but that as similar ridges of sand, gravel, or mud are formed now in the sea, so they may have been formed when the districts in question were under the sea.—*Proceedings Royal Society of Edinburgh*, VIII., 559.

F. GEOGRAPHY.*

ANEROIDS AND HYPSOMETRY.

In a supplement to the *Meteorologia Italiana*, Dr. Grassi gives the results of experimental research upon aneroid barometers. His aneroids were compared with standard mercurial barometers, both during journeys to high mountains and during exposure in the ordinary receivers of air-pumps. Among the results given by him, we note that, in addition to the generally recognized fact that the aneroids are subject to sudden changes when at all roughly handled, each aneroid has a system of corrections peculiar to itself, and the further fact that sudden jumps peculiar to an aneroid are produced at corresponding or symmetrical points, according as the pressure is diminished or increased.

In a second paper upon the correlated subject of barometric hypsometry, he calls attention to the important works of St. Robert and Ruhlmann, and shows that the formula deduced by the former investigator leads to quite as reliable results as that of the latter. In an appendix he gives a convenient table for calculating altitudes, for the use of Italian meteorologists, based upon the formula of St. Robert.

NEW HYPSOMETRIC TABLES.

The tables constructed by Biot, in 1811, for the computation of altitudes by means of barometric observations, were as convenient as could be desired for this purpose, but have recently been published in a much greater fullness by Kiefer, of Tiflis, who has also given them a still more convenient form. He states that he separates the original Biot's formula into three portions, depending respectively on, first, the pressure; second, the pressure and the temperature; and,

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* The fullness of the systematic account of the progress of geographical science in the Summary enables us to reduce the amount of space usually devoted to this subject in the body of the "Annual Record."—*Ed.*

third, the pressure, temperature, and altitude. The advantages which the new tables of Kiefer possess over the older ones of Biot are, first, all interpolations are avoided, and there is left for the computer only the simplest operations, viz., addition and subtraction, which can even be executed upon the abacus that is so widely used in Russia. Second, the terms depending upon the temperature of the air and the altitude are separated from those that are independent of these arguments; so that we see directly the influence of these upon the result. Third, notwithstanding that the extent of the new tables does not exceed 114 small pages, yet is the range so extended as to cover any altitude that can possibly occur even in the Caucasus. Kiefer's tables do not take account of the moisture in the atmosphere, because, as he says, the computations that introduce that argument give results differing from the geodetic determinations more than if moisture is omitted.—*Biot's Tafeln, computed by Kiefer, Tiflis*, 1874.

NEW FORM OF MERCURIAL HORIZON.

Those who have had frequent occasion to observe the heavenly bodies as reflected from a bath of mercury will welcome the announcement that it is possible to construct such a bath in a manner to diminish, if not entirely obviate, the very annoying vibrations to which the mercury is subject even when the origin of the vibration is unknown. Such a bath of mercury, established upon a pier of its own, entirely isolated from the building, has been known to tremble under the influence of vibrations communicated from railroad trains, or the blasting of rocks, from two to five miles distant. In the neighborhood of a large city the surface is never quiet by day or night. In order to obviate this annoyance, it is well known that Professor Airy, of Greenwich, suspended the basin containing the mercury from the fourth of a set of four frames, each of which was suspended from the other by threads of India rubber. By this means the mercury was relieved from the influence of the minute vibrations to which the ground near London is continually subject. Mr. Lane, of the Coast Survey, however, announces that if in the bottom of the basin, near its edge, we cut a circular trough, such that the greater mass of the mercury may run into it, we may leave over the

greater portion of the remaining bottom surface of the basin a thin layer of mercury, possibly the one hundredth of an inch deep, which will not be troubled by the ripples that originate near the edges of the basin. It is easy, he says, by gentle taps upon the trough, to observe these ripples starting from the edge, but quickly dying out as they come upon the plateau where the mercury is relatively shoal. It might be anticipated that a slight inclination of the basin would materially alter the horizontality of the surface of the mercury. He states, however, that this is not the case to any injurious extent, the momentary tilting of the mercurial surface being immediately followed by a resumption of its horizontality. Mr. Lane's arrangement for procuring a thin, steady horizontal mercurial film seems to be an improvement upon that proposed many years ago by Lamont, and will doubtless be found exceedingly convenient in many astronomical observations, if it be not injuriously affected by inequalities of temperature, as Lamont showed was the case in his own apparatus.—*Coast Survey Report*, 1871, 189.

CORRECTION OF ASSUMED ALTITUDES IN THE UNITED STATES.

Mr. James T. Gardner, the Geographer of the United States Geological and Geographical Survey of the Territories under Professor F. V. Hayden, has published an elaborate discussion of the evidence upon which rested the supposed altitudes of leading points in the Northern and Western United States, our great lakes, rivers, cities, mountains, etc. He had before him a collection of over 1200 railroad and canal profiles, and among this mass were many conflicting statements. Corrected profiles were joined together into various lines extending from ocean tide-gauges to the interior of the country. These lines focusing at great railway centres, gave the means of determining the altitude of each of them by a number of independent methods. Different results accord so closely, and evidence is given with such completeness, that Mr. Gardner's work must be considered to have established the altitudes of the United States. The height of the mean surface of Lake Erie is shown to be 573.08 feet, and of Lake Michigan, 589.15 feet above the sea. This differs considerably from former results, and Mr. Gardner points out the old

sources of error. The whole lake region is changed by the same amount as the lakes.

The following are some of his results:

	Feet.
The Cincinnati City Directrix	439.74
Pittsburgh, Main Depot track	746.00
Harrisburg, Pa., Railroad Depot track	319.91
Philadelphia, City datum	8.78
Albany, mean tide in river	4.84
Lake Champlain	100.84
Lake Ontario, mean surface	250.00
Indianapolis, Main Depot track	721.75
Cairo, city base of levels	291.23
St. Louis, City Directrix	428.29
Chicago, City Directrix	587.15
Rock Island, C. R. I. and P. Depot track	568.68
Burlington, Iowa, Main Street Depot	531.61
Omaha, top of abutments of railroad bridge	1,049.40
Kansas City, mark of high water of 1844	770.77
Denver, K. P. R. R. Depot track	5,196.58
Cheyenne, U. P. Depot track	6,075.28
Pike's Peak	14,146.68
Mount Lincoln	14,296.66

These heights are largely different from previous estimates. Our great railway centres and entire states are raised 10 to 115 feet in altitude. The whole of some parts of the continent seems to be much higher above the sea than was supposed. One of the most interesting results of the investigation is that it shows our American railroad levels to be very accurate when long lines are considered. The New York Central and Lake Shore and Michigan Southern Railroads joined with the Illinois Central and Southern Railroads to New Orleans make a continuous line of levels 1800 miles long from New York Bay. They reach the Gulf of Mexico with an error of only two and a half feet. The two great independent lines—the Union Pacific and the Kansas Pacific Railroads—reach Denver with a difference of only five feet. Such accuracy in American leveling speaks well for our engineers. The careful determination of altitudes of high and low water at a number of points on the Ohio, Mississippi, and Missouri Rivers is one of the most important contributions, establishing, as it does, the true fall of these rivers at different stages of water—a subject of which our previous knowledge was very inaccurate. Mr. Gardner closes with a

list of altitudes of 150 carefully located points. Those especially interested in the paper will find it in the Report of the United States Geological and Geographical Survey under Professor F. V. Hayden for 1873.

THE BATHOMETER OF DR. C. W. SIEMENS, F.R.S.

In a report to the Secretary of the Navy on the Loan Exhibition of Scientific Instruments at South Kensington, by Professor E. S. Holden, U. S. N., are some interesting remarks upon this ingenious instrument.

Professor Holden says: The best description of this instrument is to be found in *Nature* for March 30, 1876, from which the following account is taken: A paper has been presented to the Royal Society "On determining the depth of the sea without the use of the sounding-line," by Dr. C. W. Siemens, who gave at the meeting of the 24th of February, 1876, a description of the instrument which he has designed with this object. He commenced by giving a mathematical statement of the effect of local attraction, to a certain depth, on a body placed at the surface of the earth, assuming it to be of uniform density, spherical in form, and unaffected by centrifugal action. For small values of depth (h) this attraction is $2\pi h$. The original formula from which this is adduced is:

$$2\pi h\left(1-\frac{2}{3}\sqrt{\frac{h}{2R}}\right),$$

and by substitution of $2R$ for h in this, Newton's statement of the total attraction $\frac{4}{3}R\pi$ is obtained.

Now, if in place of the solid substance which forms the exterior crust of the earth, whose density may be taken to be the mean density of superficial rock, water, a material of less density, is substituted, it is shown that the total attraction must be diminished, and the measure of this diminution is a measure of the depth of light substance which has been substituted for heavy. If we were in possession of the exact mean density of the earth, of that of the surface-rock, and of sea-water, a scale could be calculated beforehand to show what depth would agree with a certain diminution of the measured effect of gravitation. Such an approximate

calculation was made in designing the instrument, but Mr. Siemens has preferred to compare the readings of the instrument with actual soundings, in order to obtain a scale.

The instrument, which is called a bathometer, consists of the following parts: A weight, being a column of mercury affected by variation of gravitation; a counterbalance, being springs unaffected by variation of gravitation; and an arrangement by which variations in gravitation can be read as depths in units. The column of mercury is maintained in a vertical steel tube having cup-like extensions, the lower portion being closed by a corrugated diaphragm of thin steel plate, and the upper portion containing an aperture for filling the instrument, having a screw stopper. The internal diameter of the tube is reduced at the upper portion, in order that the vertical oscillations of the mercury produced by the motion of a vessel in a sea-way may be reduced to a minimum; and the instrument is suspended in a universal joint above its centre of gravity, so that it may always hang in a vertical position at sea, and is inclosed in an air-tight casing, so that it may not be under the influence of atmospheric changes. The weight of the column of mercury is balanced at the centre of the diaphragm by the elasticity of the steel springs, and the *modus operandi* of the instrument is evident; as the mercury diminishes in potential through the effects of diminished attraction, the action on the springs diminishes, and these shorten upon themselves.

There are some peculiarities in the mechanical arrangement of the instrument which repay examination. Both ends being open to the air, its indications are not affected by variations of atmospheric pressure. With regard to temperature, the instrument is *parathermal.*

Professor Holden states that by the courtesy of Dr. Siemens he was enabled to see the manuscript account of soundings taken with this instrument on board the *Faraday* in October and November, 1875, and in March and April, 1876. During her voyage across the Atlantic at that time frequent soundings were made with the piano-wire sounding apparatus of Sir William Thompson, and at each one of these soundings the bathometer was read by Dr. Hicks, who had it under his charge. The results are exhibited in the following table:

A. Bathometer.	B. Piano-wire.	A–B. Error of Bathometer.	(A–B)÷B.
Fathoms.	Fathoms.	Fathoms.	Proportion of Error.
201	197	+ 4	+0.020
99	100	– 1	– .010
63	54	+ 9	+ .185
82	82	0	.000
218	214	+ 4	+ .019
78	69	+ 9	+ .130
56	54	+ 2	+ .037
55	54	+ 1	+ .017
20	56	– 6	– .107
47	54	– 7	– .130
50	58	– 8	– .138
66	69	– 3	– .043
82	73	+ 9	+ .122
56	47	+ 9	+ .171
49	46	+ 3	+ .065
80	69	+ 11	+ .160
111	100	+ 11	+ .110
215	200	+ 15	+ .075
69	64	+ 5	+ .078
80	80	0	.000
86	86	0	.000
68	76	– 8	– .105
388	353	+ 35	+ .099
799	698	+101	+ .143
607	503	+104	+ .206
2789	2516	+273	+ .108
2388	2320	+ 68	+ .029
1907	1861	+ 46	+ .025
1615	1700	– 85	– .050
Mean........................			0.083

The following soundings were taken in March and April, 1876, by Alexander Siemens, Esq., near Nova Scotia. Some sources of error had in the meanwhile been removed:

A.	B.	A–B.	(A–B)÷B.
90	90	0	0.000
94	92	+ 2	+ .022
95	94	+ 1	+ .011
107	101	+ 6	+ .059
105	105	0	.000
64	64	0	.000
64	61	+ 3	+ .049
56	53	+ 3	+ .057
66	68	– 2	– .030
29	27	+ 2	+ .074
43	38	+ 5	+ .132
Mean........................			0.039

It will be seen from the table that the mean error is a little over eight per cent. for the first trials, during which time the instrument (which was the first of its kind) was subject to various sources of error, some of which have now been removed by better mechanical arrangements, and a few of which remain to be overcome. It will also be observed from the second part of the table that in April, 1876, after certain of these mechanical difficulties had been overcome, the percentage of error was much reduced, so that a sounding by the instrument and one by the line agreed on the average to within abont *four per cent.* Dr. Siemens is now engaged in incorporating some improvements into a new instrument of this kind, and in particular in substituting for the corrugated diaphragm, which supports the column of mercury, one made of steel which is sawed through in a spiral form and covered by a sheet of India rubber.

In the trial of this first bathometer, Dr. Siemens took it to the top of the great clock-tower of the Houses of Parliament (315 feet), and it was found to read very closely what theory demanded. It may be reasonably hoped that the mechanical difficulties, which are very great, can be so far overcome as to cause the instrument to be read in the open sea within one or two per cent. of the true depth on the average. It must be remembered that the piano-wire apparatus gives the depth of water immediately below the ship, while the bathometer gives an indication of an attraction (or of a deficiency) which is the result of the depth of water for several miles in every direction. It gives the mean depth over a certain area.

A difficulty will always arise in the use of this device as a *navigating* instrument in general, as on approaching close to the land it will give an indication due not only to the depth of water beneath the ship, but partially due to the height of the neighboring land above the level of the sea. Thus we may expect to find *always* a reading of the instrument near the shore which will be different from what it would give in the open sea over the same depth of water, and hence, for general cruising, such an instrument will be an uncertain guide of a close approach to land. When, however, the water shoals gradually, so that the 100-fathom line is twenty-five to forty miles from shore in which case the

disturbing effect of the distant shore would be very small, it would indicate with great certainty the shoaling of the water, and a simple observation of the *rate* of shoaling could not fail to be of service to the navigator.

The foregoing objections would not apply, however, in a case where the instrument was placed on a packet-ship which was continually making the same voyage, as on one of the Atlantic steamers for example.

If whenever the ship's position was known the bathometer was read and the reading entered on the chart, and if after ten or twenty voyages a particular instrument was constantly seen to have the same reading when the ship was in a given position (as it undoubtedly would), it could not fail to be trusted as a warning and as an aid. By an experience of this kind a table of the bathometer readings which corresponded to particular positions could be made and thoroughly tested on such a vessel, which is constantly crossing in the same track, so that after a time the reading of this particular bathometer would become an important sign of nearing a coast.

In this way, with intelligent officers who would not fail to put the necessary tests to it, it may yet be deemed suitable to serve as an important aid to navigation. Its great use will be, for the present, on board of special surveying ships, to indicate not so much the actual and absolute depths as the *changes of depth.* If, for example, a ship is engaged in making soundings with a trustworthy apparatus on board, and if it is found that a given depth by the piano-wire always corresponds very nearly to the same reading of the instrument (as it would), and if this continues to be so, then a change in the reading of the bathometer would indicate to the commanding officer the passage over shoaler or deeper water, as the case might be, and it would show the necessity for a new sounding—a necessity which otherwise would be overlooked. In the hands of intelligent officers this instrument, which is now an experiment merely, may become of great value, and it is quite within reasonable expectations to hope for valuable aid from it in its perfected form.

It is understood that an instrument of this class will soon be in the possession of the Navy Department, and one has been proposed for use on H. M. S. *Fawn*, and upon the re-

ports of the officers who will have it in charge a correct appreciation of its practical usefulness can be based.

WORK ACCOMPLISHED BY THE CHALLENGER.

The thoroughness of the equipment of the *Challenger*, the abilities of the several officers and assistants, and the favorable circumstances generally combined to render this expedition one of the most fortunate and successful of any on record. Indeed, it may well be considered as marking an epoch in the scientific history of the world.

The first important advance made by the *Challenger* on our previous knowledge of the deep seas was in the discovery of a vast extent of red clay on the floor of the ocean at profound depths, and the comparative absence of life there. This extends far into the South Atlantic, merging into gray ooze to the north, while to the south a remarkable deposit of silicious matter covers the Antarctic Sea floor. The small amount of carbonate of lime and large amount of alumina and oxide of iron contained in it render its formation extremely difficult to understand. An important deduction is made that while this formation is going on to an immense extent, with but little trace of organic life in the depths below, the sea above teems with a variety of animal forms, thus having an exact analogy in well-known terrestrial strata. The cause of the absence of organic remains, as suggested by Professor Thomson, lies in the large amount of carbonic-acid gas held in suspension by the sea at great depths, which acts as a solvent on the carbonate of lime, leaving only the decomposed residuum to increase the thickness of the sea bottom.

Another result of the *Challenger's* work has been to establish as general principles what was only known to exist in isolated instances, namely, the universal lowering of the temperature of the great seas with increasing depth.

Previous expeditions have shown that the fauna of the deep seas contained species, genera, and groups which existed during past ages, many of them being forms known only as fossils, thus surviving the various alterations that accompanied the geological periods. Numerous additional illustrations were found in connection with the expedition of the *Challenger*, which will doubtless in due time be brought forward.

In addition, however, the *Challenger* has shown that many of the species occur over very wide ranges in portions of the sea bottom far apart, especially those of great geological antiquity, forms being found in the New Zealand seas having a general resemblance to those at the same depth off Portugal and North Africa.

Some extremely curious forms of animal life were obtained by the *Challenger*, among them one crab that appeared to be all eyes, and another without any. The two remarkable sea-urchins obtained in the *Porcupine* expedition, *Salenia* and *Pourtalesia*, were found by the *Challenger*, the latter over a wide area. A great hydroid was found, as large as a young tree, and many sponges of exquisite beauty. The globigerina, under the careful examination of surface specimens, proved to have a spiny coat surrounding the holes, through which the contractile and motile yet structureless protoplasm protrudes.

The deepest Atlantic sounding was made nearly ninety miles north of St. Thomas, in 3875 fathoms; the deepest in the Pacific was about five degrees east of Jeddo, 3950 fathoms, with a bottom of red clay. In the Pacific there were some very important observations made in regard to the existence of confined basins at the sea bottom, having a uniform temperature for a considerable depth. The depth of these submarine basins was ascertained by noting the distance over which the same temperature was maintained. When the thermometer indicated a gradual lowering of temperature to a certain point, and then remained unchanged with increasing depth, it was concluded, with great show of reason, that the area was surrounded by a barrier without any opening through which the bottom waters could penetrate. No such basins were found in the Atlantic.—13 *A*, *June* 3, 1876, 538.

SWEDISH ARCTIC EXPLORATIONS TO 1875.

The Swedish government publishes in a small pamphlet a general account of Sweden, and a catalogue of the objects presented by the Swedish government for exhibition in the International Geographical Congress at Paris in 1875. In this volume we find noticed the following Swedish expeditions for the exploration of the arctic regions: In 1837

Professor Sven Loven began an expedition to Spitzbergen which continued until 1838, in which year the French government sent out a similar expedition, generally known as the Commission du Nord. In 1857 Torell explored Iceland, and in 1858 Nordenskjöld visited Spitzbergen. In 1859 Dr. Torell explored a portion of Greenland. In 1861 a government expedition left Tromsö for Spitzbergen, Dr. Torell being chief, with Nordenskjöld and others as his collaborators. In 1863 Dr. Quennerstadt undertook an expedition to the island of Jan-Mayen and the neighboring seas. In 1864 a third Swedish expedition was sent to Spitzbergen, Dr. Nordenskjöld being chief of the scientific corps. In 1865 Dr. Paijkull explored Iceland. In 1868 a fourth Swedish expedition was made to Spitzbergen, under the direction of Nordenskjöld and a considerable corps of scientists, in which expedition Beeren Island was visited. In 1870 Dr. Nordenskjöld undertook a voyage to Greenland, hoping to make use of Esquimau dogs for sledge journeys. The principal field of their explorations was the west coast of Greenland, between the 68th and 71st degrees of latitude. This expedition was very successful in the collection of large masses of meteoric iron. In the spring of 1871 an expedition to Greenland was made by a vessel of the Swedish Navy, under the command of Baron Von Otter. In 1872 an expedition intended to pass the winter at Spitzbergen was sent out, consisting of three vessels, under Palander and Crazensteon; and two other Swedish expeditions were also sent to Spitzbergen under private expense—one in 1870, with the object of exploring the phosphatic strata. The second expedition of 1872 was also urged in the same interest, but accomplished much for geology. Finally, the expedition of 1875 to Nova Zembla was carried out entirely at the expense of Oscar Dickson. It was under the scientific direction of the indefatigable Professor Nordenskjöld.

EXPLORATIONS MADE UNDER THE DIRECTION OF F. V. HAYDEN IN 1876.

For reasons beyond the control of the geologist in charge, the various parties comprising the United States Geological and Geographical Survey of the Territories did not commence their field work until August. Owing to Indian hos-

tility, the labors of the Survey were confined to the completion of the Atlas of Colorado. Therefore the work of the season of 1876 was devoted to finishing the entire mountainous portion of Colorado, with a belt fifteen miles in width of Northern New Mexico, and a belt twenty-five miles in breadth of Eastern Utah. Six sheets of the Physical Atlas are now nearly ready to be issued from the press. Each sheet embraces an area of over 11,500 square miles, or a total of 70,000 square miles. The maps are constructed on a scale of four miles to one inch, with contours of 200 feet, which will form the basis on which will be represented the geology, etc.

The point of departure the past season was Cheyenne, Wyoming Territory.

The primary Triangulation party was placed in charge of A. D. Wilson, and took the field from Trinidad, the southern terminus of the Denver and Rio Grande Railway, August 18th, making the first station on Fisher's Peak. From this point the party marched by the valley of the Purgatoire, crossed the Sangre de Christo Range by way of Costillia Pass, and followed the west base of the range northward as far as Fort Garland, making a station on Culebra Peak. About six miles north of Fort Garland is located one of the highest and most rugged mountain-peaks in the West, called Blanca Peak, the principal summit of the Sierra Blanca group. On the morning of August 28th the party started to ascend this peak. They found no difficulty in riding to timber line, which is here about 12,000 feet above sea-level. Here they were compelled to leave the animals, and carry the instruments themselves. The main summit is about two miles north of the first point, in a straight line, and connected with it by a very sharp ridge, difficult to pass on account of the loose rocks and the constant fear of tumbling. After difficult climbing they found themselves on the summit. From here a magnificent view was spread out before them. A large portion of Colorado and New Mexico could be seen. This point is the highest in the Sierra Blanca group, and, as far as is known at the present time, is the highest in Colorado. The elevation was determined by Mr. Wilson. First a mean of eight barometric readings, taken synchronously with those at Fort Garland, gave a difference between the

two points of 6466 feet; secondly by fore and back angles of elevation and depression, which gave a difference of 6468 feet. The elevation at the Fort was determined by a series of readings compared with the Signal Service barometer at Colorado Springs, giving an elevation of 7997 feet, making Blanca Peak 14,464 feet above sea-level. This peak may be regarded therefore as one of the highest in the United States. A comparison with some of the first-class peaks in Colorado will show the relative height:

		Feet.
Blanca Peak	above sea-level	14,464
Mount Harvard	" " "	14,384
Gray's Peak	" " "	14,341
Mount Lincoln	" " "	14,296
Mount Wilson	" " "	14,280
Long's Peak	" " "	14,271
Uncompahgre Peak	" " "	14,235
Pike's Peak	" " "	14,146

The foregoing table will afford some conception of the difficulty encountered in determining the highest peak, when so many occur that are nearly of the same elevation. About fifty peaks are found within the limits of Colorado that exceed 14,000 feet above sea-level.

From this point the party proceeded westward across the San Luis Valley and up the Rio Grande to its source. From the head of the Rio Grande the party crossed the continental divide, striking the Animas Park, thence by trail to Parrott City.

After making a station on La Plata Peak, the party marched northwest across the broken Mésa country west of the Dolores, making three stations on the route. After making a primary station on the highest point of the Abajo Mountains, the party turned westward to Lone Cone; thence crossing the Gunnison and Grand Rivers, they proceeded to the great volcanic plateau at the head of the White River. The final station was made between the White and Yampah Rivers in the northwestern corner of Colorado. During this brief season Mr. Wilson finished about 1000 miles of topography and made eleven geodetic stations, thus connecting the whole of Southern and Western Colorado.

In company with the Triangulation party, Mr. Holmes made a hurried trip through Colorado, touching also portions of

New Mexico and Utah. He was unable to pay much attention to detailed work, but had an excellent opportunity of taking a general view of the two great plain belts that lie—the one along the east, the other along the west base of the Rocky Mountains. For nearly 2000 miles' travel he had constantly in view the cretaceous and tertiary formations, among which are involved some of the most interesting geological questions. He observed, among other things, the great persistency of the various groups of rocks throughout the east, west, and north, and especially, in the west, that from Northern New Mexico to Southern Wyoming the various members of the cretaceous lie in almost unbroken belts, while the tertiaries are hardly less easily followed.

Between the east and the west there is only one great incongruity. Along the east base of the mountains the upper Cretaceous rocks, including Nos. 4 and 5, are almost wanting, consisting at most of a few hundred feet of shales and laminated sandstones. Along the west base this group becomes a prominent and important topographical as well as geological feature. In the northwest, where it forms the "Mésa Verdé," and the cap of the Dolores plateau, it comprises upward of 2000 feet of coal-bearing strata, chiefly sandstone, while in the north it reaches a thickness of 3500 feet, and forms the gigantic hog-back of the Grand River Valley.

While in the southwest he visited the Sierra Abajo, a small group of mountains which lie in Eastern Utah, and found, as he had previously surmised, that the structure was identical with that of the four other isolated groups that lie in the same region. A mass of trachyte has been forced up through fissures in the sedimentary rocks, and now rests chiefly upon the sandstones and shales of the lower Cretaceous. There is a considerable amount of arching of the sedimentary rocks, caused probably by the intrusion of wedge-like sheets of trachyte, while the broken edges of the beds are frequently bent abruptly up as if by the upward or lateral pressure of the rising mass. He was able to make many additional observations on the geology of the San Juan region, and secured much valuable material for the coloring of the final map.

He states that the northern limit of the ancient cliff build-

ers in Colorado and Eastern Utah is hardly above latitude 37° 45'.

The Grand River Division was directed by Mr. Henry Gannett, topographer, with Dr. A. C. Peale as geologist. Mr. James Stevenson, executive officer of the Survey, accompanied this division for the purpose of assisting in the management of the Indians, who last year prevented the completion of the work in this locality by their hostility.

The greater portion of the work of this division lay north of the Grand River, limited on the north by the parallel of 39° 30', and included between the meridians of 108° and 109° 30'.

This division took the field at Cañon City, Colorado, about the middle of August. The party traveled nearly west, up the Arkansas River, over Marshall's Pass, and down the Tomichi and Gunnison Rivers to the Uncompahgre (Ute) Indian Agency. Here they secured the services of several Indians as escort in the somewhat dangerous country which they were first to survey. This area lying south of the Sierra La Sal was worked without difficulty. It is a broken plateau country, and presents many curious pieces of topography. Eleven days were occupied in this work.

The Grand River, from the mouth of the Gunnison to that of the Dolores, *i. e.*, for nearly a hundred miles, flows along the southern edge of a broad valley, much of the way being in a low cañon, one hundred to two hundred feet deep. The course of the river is first northwest for twenty-five miles, then, turning abruptly, it flows southwest, and then south for about seventy-five miles. This valley has an average width of twelve miles. It is limited on the north and west by the Roan, or Book Cliffs, and their foot-hills, which follow the general course of the river. These cliffs rise from the valley in a succession of steps to a height of about 4000 feet above it, or 8000 to 8500 above the sea.

From its crest, this plateau (for the Book Cliffs are but the southern escarpment of a plateau) slopes to the N.N.E. at an angle of not more than 5°. It extends from the Wahsatch Mountains on the west to the foot-hills of the Park Range on the east, and presents every where the same characteristics. The Green River crosses it, flowing in a direction exactly the reverse of the dip. It borders the Grand on the north for

one hundred and fifty miles, the east forming the divide between the Grand and the White. On the south side of the crest are broken cliffs; on the north side, the branches of the White cañon immediately. This leaves the divide in many places very narrow, in some cases not more than thirty to forty feet wide, with a vertical descent on the south toward the Grand River, and an extremely steep earth slope (35° in many cases) at the heads of the streams flowing north to the White River. This crest, though not over 8500 feet in height, is the highest land for a long distance in every direction.

After leaving the Uncompahgre Agency, the party followed Gunnison's Salt Lake road to the Grand, and down that river to the mouth of the Dolores, in latitude 38° 50′, longitude 109° 17′. At this point they turned northward, and went up to the crest of the Book Plateau. They followed this crest to the eastward for upward of a hundred miles to longitude 108° 15′, and thence *via* the White River (Ute) Indian Agency to Rawlins, where they arrived on October 23d.

The whole area worked is about 3500 square miles, in surveying which about sixty stations were made.

The geological work of this division, by Dr. Peale, connects directly with that done by him in 1874 and 1875. Sedimentary formations prevail on both districts visited the past season.

The country first examined lies between the San Miguel and Dolores Rivers, extending northward and northwestward from Lone Cone Mountain. The general character of this region is that of a plateau cut by deep gorges or cañons, some of which, especially toward the north, extend from the sandstones of the Dakota group to the top of the red beds. The depth of the cañon, however, is no indication of its importance as a stream-bed, for away from the main streams they are dry the greater portion of the year. There are not great disturbances of the strata, what folds do occur being broad and comparatively gentle.

The San Miguel River, leaving the San Juan Mountains, flows toward the northwest, and with its tributaries cuts through the sandstones of the Dakota group, exposing the variegated beds lying beneath, that have generally been referred to the Jurassic. About 25 or 30 miles north of Lone Cone the river turns abruptly toward the west, and flows

west and southwest for about 15 miles, when it again turns, and flows generally northwest until it joins the Dolores. Between the San Miguel and Lone Cone, the sandstones of the Dakota group (or No. 1 cretaceous) are nearly horizontal, forming a plateau which, on approaching the mountains, has a capping of cretaceous shales.

Beyond the bend, the San Miguel flows in a monoclinal valley, in which the cañon walls are of the same description as in the upper part of its course. As the mouth is approached the red beds appear. Between this portion of the course of the San Miguel and the almost parallel course of the Dolores, which is in a similar monoclinal rift, there are two anticlinal and two synclinal valleys parallel to each other. They are all occupied by branches of the Dolores. Lower Cretaceous, Jurassic, and Triassic strata outcrop, and present some interesting geological details, which will be fully considered in the report on the district. The Dolores River comes from a high plateau in a zigzag course, flowing sometimes with the strike and sometimes with the dip of the strata. Its general course on the western line is about northwest, from which it turns to the northward and westward, finally changing to northwest again to its junction with the Grand. It is in cañon the greater part of its course. In the region of country north of Grand River the geological formations extend uninterruptedly from the red beds exposed on Grand River to the white tertiary cliffs forming the summit of the "Roan Mountains," or Book Cliffs. The Grand is generally in a cañon in the red beds.

On the north side the No. 1 cretaceous sandstone forms a hog-back sloping toward the cliffs. Between the crest of this hog-back and the cliffs there is a broad valley formed by the erosion of the soft cretaceous shales which extend to the base of the cliffs, and in some places form their lower portion. The cliffs are composed mainly of cretaceous beds, rising one above another in steps, until an elevation of about 8000 feet is reached. The summit is the edge of a plateau sloping N.N.E. This plateau is cut by the drainage flowing into the White River from the south. These streams rarely cut through the tertiary series.

Coal of poor quality is found in the sandstones of the Dakota group, and also in the sandstones above the middle

cretaceous beds. Wherever noticed, it was in thin seams and of little economic importance.

The White River Division was directed by G. B. Chittenden as topographer, accompanied by F. M. Endlich as geologist.

The district assigned to this party as their field for exploration during the season of 1876 commenced from the eastward at longitude 107° 30′, joining on to the work previously done, and extended westward 30 miles into Utah Territory. Its southern boundary was north latitude 39° 30′, while the White River formed the northern limit. In order to take the greatest possible advantage of the short time that could be allowed, it was determined to make the White River Agency the head-quarters, and in two trips from there complete the work. About 3800 square miles comprised the area surveyed.

In working up the topography of the district, the party spent 48 days of absolute field-work, made 41 main topographical stations and 16 auxiliary ones, and traveled within the district about 1000 miles. The party ascertained the course of all the main trails, the location and quality of nearly all the water—which is scanty throughout—and can map with considerable accuracy the topographical forms and all the water-courses. The area is almost entirely devoid of topographical "points," and the topographer is obliged to depend to a considerable degree on those far to the north and south for the triangulation. The country has been heretofore almost entirely unexplored, and was described by the nearest settlers as a broken cañon country, extremely dry. It was marked on the maps as a high undulating plateau, with fresh-water lakes and timber. The party saw no lakes of more than four hundred yards in diameter, and only two or three of those. The country is nearly all inhabitable both winter and summer, and considerable portions of it valuable, and, though three quarters of it is within the Ute Indian Reservation, the advantage of a more accurate knowledge of its character can readily be seen.

Altitudes were determined by the mercurial barometer, with a base at the White River Indian Agency, and checked by a continuous system of vertical angles. The altitude of the Agency has been determined by a series of barometric

observations extending over two years and a half, and referred to railroad levels, and can probably be depended on to within a few feet.

The general topography is a gentle rise from the White River toward the south, and a sudden breaking off, when the divide is reached, into ragged and often impassable cliffs, known on the maps as the Roan or Book Mountains. The gentle plateau slope of the White River side is cut by almost numberless and often deep cañons, and in many cases the surface of the country has been eroded away, leaving broken and picturesque forms, the lower benches generally covered with cedars and piñons, and the upper rich in grass.

There are four main streams draining into the White River within the limits of our work—a distance of something over 100 miles. All of these streams have more or less good water at their heads. They traveled nearly the whole length of all these water-courses, but found good trails only in the middle ones. Trails, which traverse the whole district in every possible direction, keep mostly on the summit of the ridges and plateaus, and, by taking care not to cross the cañons, the country is very easily traveled through.

The country is almost entirely destitute of timber, and has but little good water. It is, however, abundantly supplied with grass, and, especially in the winter season, must be well stocked with game.

In the far western portion, and outside the limits of the Reservation, one large vein of asphaltum and several small veins were found, and also running springs of the same material—all of which, if once reached by railroad, will prove of great commercial value. These deposits have been spoken of before, but their location has not been accurately determined.

According to the report of F. M. Endlich, the geology of the district is very simple, though interesting. Inasmuch as but one divide of importance occurred within the district, the work was somewhat simplified. This was formed by the Book Cliffs—between the drainages of the Grand on the south and the White on the north. Both of these rivers flow a little south of west into the Green River, which they join in Utah. From the junction of the Grand and Green downward, the river is called the Great Colorado. Orograph-

ically the region surveyed is comparatively simple. The Book Cliffs are the summit of a plateau about 8000 feet above sea-level, continuing unbroken over to the Green River. Toward the south these cliffs fall off very steeply, forming deep cañons that contain tributaries of the Grand River. On the north side, with the dip of the strata, the slope is more gentle, although in consequence of erosion numerous precipitons cliffs are found. Descending in that direction, the character of the country changes. Instead of an unbroken slope, we find that the plateau has been cut in parallel directions by the White River drainage, and the long characteristic mésas of that region testify to the character of erosion. Approaching the river, constantly descending with the slight dip of the strata, the bluffs become lower and lower. Though the creek valleys are wide, and at certain seasons no doubt well watered, the vegetation is that of an arid country. Dwarf pines, piñons, and sage-brush abound, to the almost entire exclusion of other trees or grass. Traveling down White River, this character is again found to change. A new series of bluffs, occasioned by heavy superincumbent strata, gives rise to the formation of deep cañons.

For 45 miles the party followed the cañon of the White, which, no doubt, is analogous to that of the Green, and probably closely resembles that of the Colorado in its detail features. Vertical walls inclose the narrow river-bottoms, and the slopes of the higher portions are ornamented by thousands of curiously eroded rocks. Monuments of all kinds, and figures that can be readily compared to those of animated beings, enliven the scenery, which otherwise would be very monotonous. Two to three thousand feet may be stated as the height of the walls inclosing the White River.

Geologically speaking, the district was one of singular uniformity. Traveling westward, the older formations, reaching back as far as the Jurassic, were found. This was followed by cretaceous, which in turn was covered by tertiary. About three quarters of the region surveyed was found to contain beds belonging to this period.

Owing to the lithographical character of the strata, water was a rare luxury in this region, and men and animals were frequently dependent upon finding springs.

Farther west still the Green River group sets in, forming

those numerous cañons of which that of the White River is one. Having completed their work by October 14th, the party marched eastward through Middle Park, and, after twelve days of rain and snow, reached Boulder City, Colorado.

The field-work of the Yampah Division during the past season was principally confined to a district of Northwestern Colorado lying between the Yampah and White Rivers, and between Green River and the subordinate range of mountains that lies west of and parallel with the Park Range. The area is embraced between parallels 29° 30′ and 40° 20′, and meridians 107° 30′ and 109° 20′.

The party consisted of Mr. G. R. Bechler, topographer directing, accompanied by Dr. C. A. White, the well-known geologist. They proceeded southward from Rawlin's Springs, a station on the Union Pacific Railroad, August 6th, toward their field of labor. From Rawlin's Springs to Snake River, a distance of eighty miles, table-lands form the chief feature of the topography; while from Snake River to the Yampah River the distance is more undulating, and thickly covered with sage. Between the Yampah and White Rivers, a distance of fifty miles, the country is mountainous; and on the divide between the Yampah and White Rivers the elevation is 8000 to 9000 feet. Mr. Bechler, after having formed the geodetic connection with the work of previous years, concluded to finish the more mountainous portion of the area assigned to him, which began from a line of meridian with the White River Agency, and extended westward to about 108° 10′. Here the party found water and grass in abundance, with one exception. The plateau country, however, was so destitute of water, and so cut up with dry gorges or cañons, with scarcely any grass or timber of any kind, that traveling was rendered very difficult. The party, therefore, made White River its base of supply for water and grass, making side trips into the barren hill-tops or plateaus in every direction.

From the Ute Agency, which is located approximately in lat. 38° 58′ and long. 107° 48′, the White River takes an almost due west course for fifteen or eighteen miles, most of the way through an open valley, with here and there narrow gorges. About fifty miles from the Agency the river opens

into a broad, barren valley, with only here and there scanty patches of vegetation. Soon after it enters a deep cañon with vertical walls, 1000 feet or more in height, and continues to increase in depth until its junction with the Colorado River of the West. The Yampah or Bear River deviates from a westerly course only for a few miles occasionally. Like White River, it flows through a plateau country which rises gently from the river, back for a distance of about eight miles. South of the river lie the Williams River Mountains, which have a gradual slope to the north. Williams Fork, flowing from a southeastern direction, joins the Yampah River. West of the junction, the Yampah traverses the country more or less in a cañon, cuts through the Yampah Mountains, when it joins with the Snake River. The place of junction resembles a fine park, surrounded on all sides with eroded terraces and plateau spurs, that rise by steps to the divide on either side. This park is about eight miles in length from east to west.

After leaving this park, the river enters a huge fissure in the mountains, where it remains until, completing its zigzag course, it joins the Green River in lat. 32° and long. 109° 40′. After the junction with the Yampah, the Green River continues in a cañon for fourteen miles, when it passes through the picturesque palisades of Split Mountain into an open, broad valley (lat. 40° 28′, long. 109° 15′), from which point it takes a southeastern direction through the Wamsitta Valley, where it unites with the White River.

Into both the White and Yampah Rivers numerous branches extend from either side, forming deep cañons the greater portion of their length. We may say, in brief, that the sides of the valleys expand and contract, at one time forming the beautiful grassy valleys which in olden times were celebrated as the favorite wintering-places for the trappers, or contracting so as to form narrow cañons or gorges with walls of varied height.

The walls of Yampah Cañon average about 1000 feet, while the mountains, receding to the northward, attain an elevation of 4200 feet, the highest point of the plateau on the south side being 3400 feet above the river level.

Of the plateaus between the White and Yampah Rivers, Yampah Plateau is the largest, and occupies an area of 400

square miles. The surface of the summit is undulating, presenting on the south side a steep face, several hundred feet in height, covered with *débris*, rendering it almost inaccessible. This plateau is covered with excellent grass, and gives origin to numerous springs, all of which dry up within a short distance of their source. As a whole, this district is very arid, and almost destitute of tree vegetation.

The total number of stations made by Mr. Bechler, in the district assigned to him, was forty, and the entire area about 3000 square miles. Barometric observations were made whenever needed, and about 2000 angles of elevation and depression with fore and back sights, so that the material for obtaining the correct altitudes is abundant.

The rocks of this district embrace all the sedimentary formations yet recognized by the investigators who have studied the region that lies between the Park Range and the Great Salt Lake, namely, from the Uintah quartzite (which underlies the carboniferous) to the group or latest tertiary, inclusive. Not only have the geographical distributions of these formations been mapped, but all the displacements of the strata have been traced and delineated, the latest-named investigations bringing out some interesting and important facts in relation to the orographic geology of the region, especially as regards the eastern termination of the great Uintah uplift, and the blending of its vanishing primary and accessory displacements with those of the north and south range above mentioned. Much information was also obtained concerning the distribution of the local drift of that region, the extent and geological date of outflow of trap, etc.

The brackish water-beds at the base of the tertiary series containing the characteristic fossils were discovered in the valley of the Yampah. They are thus shown to be exactly equivalent with those now so well known in the valley of Bitter Creek, Wyoming Territory. These last-named localities were also visited at the close of the season's work, and from the strata of this horizon at Black Buttes station three new species of *Unio* were obtained, making six clearly distinct species in all that have been obtained, associated together in one stratum, at that locality. They are all of either distinctively American types or closely related to species now living in American fresh waters. They represent, by

their affinities, the following living species: *Unio clavus*, Lamarck; *U. securus*, Lea; *U. gibbosus*, Barnes; *U. metaneorus*, Rafinesgue; and *U. complanatus solander*. They are associated in the same stratum with species of the genera *Corbula*, *Corbicula neritina*, *Viriparus*, etc., and which stratum alternates with layers containing *Astrea* and *Anomia*.

The close affinity of these fossil *Unios* with species now living in the Mississippi River and its tributaries seems plainly suggestive of the fact that they represent the ancestry of the living ones. An interesting series of facts has also been collected, showing that some of the so-called American types of Unio were introduced, in what is now the great Rocky Mountain region, as early as the Jurassic period, and that their differentiation had become great and clearly defined as early as late cretaceous and early tertiary times. Other observations present the probable lines of geographical distribution, during the late geological periods, of their evolutional descent, by one or more of which they have probably reached the Mississippi system, and culminated in the numerous and diverse forms that now exist there.

The work of the past season shows very clearly the harmonious relations of the various groups of strata over vast areas; that, although there may be a thickening or thinning out of beds at different points, they can all be correlated from the Missouri River to the Sierra Nevada basin. The fact also that there is no physical or paleontological break in these groups over large areas from the cretaceous to the middle tertiary is fully established. The transition from marine to brackish-water forms of life commences at the close of the cretaceous epoch, and, without any line of separation that can yet be detected, continues on upward until only purely fresh-water forms are to be found. Dr. White, an eminent paleontologist and geologist, says that the line must be drawn somewhere between the cretaceous and tertiary epochs, but that it will be strictly arbitrary, as there is no physical break to the summit of the Bridger group.

EXPLORATION OF THE ROCKY MOUNTAIN REGION, BY J. W. POWELL.

As soon as the appropriation for the fiscal year of 1876–77 could be used, the surveying corps left Washington and

proceeded to the rendezvous camp at Gunnison, Utah Territory, where the field parties were organized under the general superintendence of Professor A. H. Thompson, geographer of the expedition. While *en route* they were joined by Captain Clarence E. Dutton, of the Ordnance Department U. S. A., who had been assigned by special orders from the Secretary of War for duty with this survey, and directed to make an examination of the immense fields of igneous rocks in Southeastern Utah.

The field organization as finally completed differed somewhat from previous years—the geographic and geological work being assigned to separate parties, each practically independent in all movements, though working under the same general plan and within the same territorial limits. It is believed that better results can be and have been secured by this separation of distinct branches of the survey than by the old method of attaching a geologist to a geographic party, or a geographer to a geological party.

Five parties were organized: one, under Professor A. H. Thompson, to continue the triangulation; one topographic party under Mr. Walter H. Graves, another under Mr. John H. Renshaw; one geological party under Mr. G. K. Gilbert, another under Captain C. E. Dutton.

The party under Professor Thompson continued the expansion of the primary triangulation, resting on the baselines measured in preceding years at Kanab and Gunnison, Utah. The area embraced in this season's work amounts to about 10,000 square miles, the instrument used being a 10-inch theodolite of peculiar construction, designed especially for this work by Professor Thompson.

Topographic party No. 1, under the charge of Mr. Graves, extended the secondary triangulation over an area of 6000 square miles, lying between the Wahsatch Mountains on the west and the Green and Colorado Rivers on the east. Mr. Graves also made a complete plane-table sketch of the country surveyed, which, taken in connection with his angles for location and perspective profile sketches, will enable him to construct a map of his district on a scale of four miles to the inch. The principal topographic characteristics of this region are long lines of unscalable cliffs, which are the escarped edges of terraced plateaus of which the country is composed,

and deep, narrow cañons with vertical walls, both presenting well-nigh impassable barriers to travel. The only considerable bodies of irrigable lands found are along the valleys of the Green and San Rafael Rivers. The only timber lands are on the Sevier plateau, at an elevation of from 8000 to 11,500 feet.

The work of topographic party No. 2, under Mr. Renshaw, was confined to Southwestern Utah and Southeastern Nevada, one of the most rugged and barren sections in the Great Basin. The methods of survey were the same as those adopted by party No. 1, except that perspective profile sketches were made by the aid of the orograph, a newly designed instrument that promises to be of great use in topographic surveying. The work of Mr. Renshaw and his able assistant, Mr. O. D. Wheeler, was extended over about 4000 square miles. In all this area no considerable bodies of irrigable lands are found—probably not one half of one per cent. possessing any value except for pasturage.

A topographic survey of the Henry Mountains was made in 1875, and a map constructed on a scale of four miles to the inch; but this being thought too small a scale to admit of correct representation of the details of the geology, Professor Gilbert, in addition to his geological work, made a more detailed survey of the topography, carrying a complete system of secondary triangulation, and a connected plane-table sketch, over more than 1000 square miles. The data collected are sufficient to make a topographic map of the Henry Mountains on the scale of two miles to the inch, or $\frac{1}{125000}$.

The Rocky Mountain region of the United States (not including Alaska), or that portion west of the meridian of 99° 30′, was by a former Secretary of the Interior divided into districts for surveying and mapping purposes, and these districts numbered; the area of each district is 2½° in longitude, 1⅔° in latitude. The region of country surveyed by the parties under the direction of Professor Powell is embraced in districts numbered 75, 85, 86, 95, 96, 104, and 105, the first five lying directly west of the region in which Dr. Hayden is engaged, while districts 104 and 105 lie immediately south of the other districts in which he himself has been at work. During the earlier part of his work, before these districts

were established by the Department, Professor Powell's work extended in an oblique direction from northeast to southwest along the general course of the Green and Colorado Rivers through the districts above designated, but the work was in such condition that no one district was complete. During the present season his parties have been engaged in extending the survey over the unsurveyed fractional districts, so that final and complete maps of each may be constructed.

The methods of survey during the present season are essentially the same as those employed during the last, being modified to a slight extent as experience has suggested; the chief improvements being in the method of triangulation. In addition to the determination of geodetic positions and general geographic features, the system of classifying the lands inaugurated in former years has been continued during the present, the object of this classification being to determine the extent and position of the irrigable lands, timber lands, grass lands, mineral lands, and waste lands—the latter being composed of rugged mountains and desert plains. The practical importance of this classification, if carefully made, is great, not only in presenting the information desirable to those who wish to settle in the country, but also in the collection of facts necessary to intelligent legislation concerning these lands.

In the region embraced in this survey, a very small portion of the country can be redeemed by irrigation for agriculture, and no part of it can be cultivated without irrigation. It appears from the reports that less than one per cent. can thus be made available. Especial care has been given to the determination of the extent of such lands, so as to exhibit their position on the maps. These irrigable lands and timber lands, together with some small districts of coal-bearing lands, are the only parts of the country that should be surveyed into townships and sections.

Having in view economy and convenience in the linear surveys of this district, the geodetic points of the general geographic survey, under the direction of Professor Powell, have been carefully marked, that they may hereafter be used as datum points by the officers of the General Land Office.

Extensive coal-fields exist in the region surveyed, but, as

in many other parts of the world, these coal-fields are of practical value only at comparatively few places. The general characteristics of these coal-fields have been the subject of much investigation, and some very interesting and valuable results have been reached. These will appear in the final reports. The quantity of available coal is practically inexhaustible, and the mines that can be economically worked are of great number.

In the Uintah Mountains silver and copper mines have been discovered, and worked by private parties. The extent of these silver and copper bearing rocks has been determined, but their value can be established only by extensive working.

Mr. G. K. Gilbert devoted much of his time to the study of the structure of the Henry Mountains, of which enough had been learned in the preceding season to warrant the belief that they embodied a type of eruption hitherto unknown. The attention given to them has been amply repaid by the elucidation of the manner of their constitution. They are volcanic; but their lavas, instead of finding vent at the surface of the ground, and piling up conical mountains thereupon in the usual manner, ceased to rise while still several thousands of feet underground, and lifted the superincumbent strata, so as to make for themselves deep-seated subterranean reservoirs, within which they congealed. Over each of these reservoirs the strata were arched, and a hill or mountain was lifted equal in magnitude to that which would have been formed if the lava had risen to the surface; but the material of the hill was sandstone and shale, instead of hard volcanic rock. Subsequent erosion has carried away more or less completely the arching strata, and laid bare many of the volcanic masses. It has revealed also a system of reticulating dikes, which go forth in all directions from the main masses, intersecting the sedimentary rocks. The lava masses, the dikes, and those portions of shale and sandstone which have been metamorphosed by contact with the molten rock, are harder than the unaltered sedimentary strata which surround them, and yield to the agents of erosion more slowly. The wash of rain and streams by which the face of the surrounding land has been degraded, has been resisted by these hard cores, and in virtue of their obduracy we have the Henry Mountains. The deposits of lava are not all in juxta-

position, but are scattered in clusters, and each cluster has created a mountain. Mount Ellen is constituted by a score of individual lava-masses; Mount Pennell and Mount Hillers each by one chief mass, accompanied by several of minor importance; Mount Holmes by two masses; Mount Ellsworth by a single one, with many dikes and sheets. Each of the mountains is an individual, topographically as well as structurally, and together they constitute a group of mountains, not a range. Mr. Gilbert's note-books contain many sketches, by the aid of which he will be able to illustrate all the features of the peculiar types of structure.

Before commencing the main work of the season, Mr. Gilbert made an excursion in search of the outlet of Lake Bonneville, the great fossil lake of Utah. During an epoch which was probably coincident with the glacial epoch, the broad interior basin of Utah was covered by a great lake, which overflowed its rim, and sent an outlet to the ocean by way of the Columbia River. When the climate became gradually warmer and dryer, the evaporation grew greater and the rainfall grew less, until finally the overflow ceased, and the lake began to dry away and shrink within its shores; to-day only Great Salt Lake and Sevier Lake remain, but high up on the mountain is carved the Bonneville beach, a permanent record of the old flood tide. The search for the point of outlet was successful, and it was found at the north end of Cache Valley, a few miles beyond the boundary of Utah, in the territory of Idaho. The bed of the outflowing stream was traced for a number of miles. The beach lines were seen to run quite to the pass through which the channel was cut, but beyond, on the side of the drainage of the Columbia, no trace of them could be seen.

Of no less interest was the discovery of a recent orographic movement at the western base of the Wahsatch Range. A great fault runs along that base—one of the faults by which the mountain was produced. The block of the earth's crust which lies to the westward of the fault-plane was dropped down, and the block which lies to the eastward was lifted up, and from the eastward block subsequent erosion has carved the range. Along this plane of ancient movement there has been a recent movement. The mountain has risen a little higher or the valley-floor has dropped a little lower, and this

so recently that the Bonneville flood is ancient in comparison.

Captain C. E. Dutton resumed this year his study of the large area of igneous rocks in Southern Utah, in the vicinity of the Sevier River, and has brought back additional information, which he purposes employing in the preparation of a monograph of the entire track. He has worked out the structure of the component features and the approximate age of the eruptions, and is engaged in classifying the various lithologic members. The older outbreaks appear to be of early tertiary age (eocene), and to have been nearly continuous through a long period. The volcanic beds thus formed were subsequently traversed by great faults, and tables were uplifted with deep valleys between them; the structure thus produced conforming to the general type prevalent throughout the plateau country. The degradation of these lofty tables gave rise to conglomerate beds of great extent and thickness, which are composed entirely of volcanic materials. Captain Dutton has compared the details and arrangement of these conglomerates with the alluvial beds now accumulating in great volume in the valleys out of the waste of the adjoining tables, and finds an agreement between them so close that he ascribes the same mode of origin to both. He also finds considerable metamorphism, not only in the underlying sedimentary beds (early tertiary), but in the superposed conglomerate, and which he thinks must have occurred comparatively near the surface. The greater portion by far of the erupted rocks he classes as trachytes and trachy-dolerites. The rhyolitic varieties are of very limited occurrence, being found only in the vicinity of the Beaver or Tushar Range. In the southwestern part of the field (near Sangquitch) extensive fields of basalt are found. Captain Dutton distinguishes two ages of the basalt, one prior to the development of the present structural features of the region, the other subsequent to it—the former being more properly dolerite or anamesite, the latter typical basalt.

Under instructions from the Interior Department, Professor Powell and his parties have also been engaged in general ethnographic work in the Rocky Mountain region. One of the special items in these instructions was the classification of the Indian tribes, such classification being not only of

scientific interest, but of great importance in the administration of Indian affairs. For the eastern portion of the United States this work had been accomplished, first, by the unofficial labors of the Hon. Albert Gallatin, and subsequently by the Hon. Henry R. Schoolcraft, as an officer of the government; and some additions had been made to this work by various persons for scientific purposes. This work has been renewed by Professor Powell, and has been pushed with all the energy possible with the funds at his command, and a large amount of material has been collected by himself and by members of his corps, and by residents in and travelers through the country. In addition to this, a large amount has been collected by the Smithsonian Institution through various channels—materials as yet unpublished. The officers of that Institution have placed all this matter in the hands of Professor Powell, to be combined with his own collections. In the preparation of the results of these collections for publication, he has the assistance of J. Hammond Trumbull, Professor F. L. O. Roehrig, and Mr. W. H. Dall. The first volume of the reports on this subject will soon be issued. It treats of the tribes of Alaska, the western half of Washington Territory, and Northwestern Oregon, and is accompanied by maps exhibiting the geographic distribution of the tribes of these regions. A second volume, on the tribes of California, has also been sent to the government printer, which will be succeeded by others as rapidly as they can be prepared.

Dr. Elliott Coues, U. S. A., is engaged on a "Report on the Birds of the Valley of the Colorado," based primarily on the collections made by the several parties under Professor Powell's direction. This report was sent to the government printer early in the spring, and about 200 pages have already been set up.

Mr. L. F. Ward, the botanist of the corps, assisted by several gentlemen of scientific ability in this department, has been engaged during the entire year in the preparation of a "Report on the Botany of the Valley of the Colorado," which is now nearly ready for publication.

EXPLORATIONS IN 1876 OF LIEUT. GEORGE M. WHEELER, U. S. E.

The expedition of 1876 was delayed in its departure for the field because of the lateness of action by Congress in

making appropriations. Six parties were, however, organized and placed in the field for the full season, and a seventh for a part of the season, until the near approach of winter necessitated the termination of the field-work about December 1st. The work of the year was, as in 1875, divided into two sections, designated as the California and Colorado sections, the work being limited to areas in California, Nevada, Colorado, and New Mexico. In the special branches of Natural History the number of scientific observers was unavoidably reduced from the limited appropriations of money which were available.

The year marks a gratifying improvement in the grade of the geodetic and topographic work, one of the features being the collection of materials for a detailed topographical map of Lake Tahoe and the surrounding Sierra Nevada region on a scale of one inch to a mile; and of the section embracing the famous Comstock lode and its surroundings upon a scale of one inch to 500 feet. This implies no departure from the original plan of confining the general topography in the more sparsely settled regions to the amount necessary for the construction of a map on a scale of one inch to eight miles, or $\frac{1}{506880}$.

The astronomical stations occupied in 1873 by parties of this survey on the divide between Virginia City and Gold Hill, Nevada, were connected this season with the extremities of a base-line, more than four miles long, measured in the valley of the Carson River. Triangles developed from this base form the basis of the system of triangles extended over the entire area.

Main astronomical stations, with the adjacent measured bases, had been determined along the east face of the Rocky Mountains from Hughes, Colorado, on the north, to Las Vegas and Santa Fé, New Mexico, on the south, and the scheme of triangulation already begun was farther carried out.

A noteworthy feature of the past season's work is the greater attention paid to the determination of the boundaries of areas of marked natural resources, such as those valuable for agriculture, with or without irrigation, for grazing, for timber, and for mines, as contrasted with the arid or absolutely sterile parts. The outgrowth of this system will be

the preparation for the use of the government of a series of charts indicating, with a close approximation, the nature of the surface as found, and its consequent adaptability to the various industries.

A small office force has been constantly employed in constructing the maps for the finished atlas from the large amount of original material already collected.

The San Juan mining region of Southwestern Colorado has been delineated upon a scale of one inch to two miles, and shows effectively the peculiar mountain structure of this wonderful region, in which nestle the heads of seven large streams—the Rio Grande, the Lake Fork of the Gunnison, the Uncompahgre, the Unanup, the San Miguel, the Dolores, the Mancos, and the Las Animas Rivers.

During the year Vol. V. (Zoology) of the 4to Reports has been issued, containing 1023 pages, with forty-five plates and three wood-cuts.

A catalogue of the mean declination of 2018 stars, used for the determination of latitude by the zenith telescope, by Professor T. H. Safford, is passing through the press, and a volume by Professor Cope upon the Vertebrate Paleontology of portions of New Mexico is soon to be issued. The regular Annual Report of the Survey for 1876 is accompanied by seven atlas sheets, and has, in addition to the usual matter, several papers on subjects relating to Natural History, and a discussion of the possibility of diverting the Colorado River of the West for the purpose of irrigation. Two trips were made during the season of 1875 and the subsequent winter by a party under Lieutenant Bergland, U. S. A., to make certain measurements, as well as a general examination of the subject, with unsatisfactory results as regards any information pointing to a successful accomplishment of such a scheme. These results are set forth in Appendix II. of the Annual Report of the Chief of Engineers for 1876. The report upon the collections from Indian mounds, in Southwestern California, by Drs. Yarrow, Rothwell, and others, in 1875, is undergoing examination by Professor W. F. Putnam, of Harvard College, and will soon be published.

G. GENERAL NATURAL HISTORY AND ZOOLOGY.

PROFESSOR ABBE ON THE MICROSCOPE.

Mr. W. E. Fripp has translated for the "Proceedings of the Bristol Naturalists' Society" Professor Abbe's papers on the microscope. The whole is very obscurely worded, and, either from the defects of the original or the misconception of the translator, it is so difficult of comprehension that it will prove of small value to the working optician. There are, however, many valuable suggestions, and some very extraordinary and positive statements; *e. g.*, that an adequate compensation of spherical aberration is, as a matter of fact, impossible in a dry lens when the angular aperture exceeds 110°; and that hence it must be concluded that a dry objective will be less suited for ordinary scientific use in proportion as it renders visible such finer systems of lines as exceed the limits of resolving power answering to that angle. And he states that the greatest possible increase of resolving power can be obtained in a rational way only by means of immersion objectives. The immersion lens may be made, according to Professor Abbe, with an aperture of about 100° in water, somewhat more than would correspond to 180° in air—a statement directly opposed to what Mr. Wenham has claimed. Professor Abbe states positively that there exists no microscope in which there has been seen, or will be seen, any structure which really exists in the object and is inherent in its nature, that a normal eye can not recognize with a sharply defining immersion lens magnifying eight hundred times (diameters ?).

LIMIT OF VISIBILITY IN THE MICROSCOPE.

In his recent annual address to the Microscopical Society of London, the president, Mr. H. C. Sorby, F.R.S., discusses the relation between the limits of the powers of the microscope and the size of the ultimate molecules of matter. As the combined result of observation and theory, he concludes that the normal limit of distinct visibility with the most perfect microscope is one half of the wave-length of the light.

If so, even with the very best lenses (except under special conditions), light itself is of too coarse a nature to enable us to define objects less than $\frac{1}{80000}$ to $\frac{1}{100000}$ of an inch apart. It would appear, therefore, that, as far as this question is concerned, our microscopes have already reached their ultimate limit. Adopting the results as to the size of the ultimate molecules of matter arrived at by Mr. Storey, Sir W. Thomson, and Professor Clerk-Maxwell, Mr. Sorby calculates that in the smallest interval which could be distinctly seen by the best possible microscope there would be about 2000 molecules of liquid water lying end to end, or about 520 of albumen, and that, in order to see the ultimate constitution of organic bodies, we should require a magnifying power from 500 to 2000 times greater than those we now possess. He calculates that with our highest powers we are as far from seeing the ultimate molecules of organic substances as we should be from seeing the contents of a newspaper with the naked eye at the distance of a third of a mile. A spherical particle one tenth the diameter of the smallest speck that could be clearly defined with our best and highest powers might nevertheless contain no less than one million structural molecules.

SORBY'S APPARATUS FOR MEASURING BANDS IN SPECTRA.

A plate of quartz one and a half inches in thickness is cut so that the light will pass along the line of the principal axis, and is interposed between two Nicol prisms. The whole visible spectrum is thus apparently divided into eight spaces by seven well-defined bands at equal intervals, and with this peculiarity, that on rotating the polarizer or analyzer (the upper prism is furnished with a graduated ivory circle) these black bands will move over the spectrum, occupying the original positions on completion of each half revolution. Each band gradually passes from the red end to the blue, in moving from zero to zero, over a semicircle. Of course it becomes comparatively easy to construct a table of wave-lengths, in millionths of a millimeter, corresponding to each one-tenth division between the bands. The zero point is determined by causing the upper Nicol to rotate until the centre of the second dark band from the red end of the spectrum exactly coincides with the sodium line, or

solar line D.—*Monthly Microscopical Journal, December*, 1875.

NOBERT'S TEST-PLATE.

In a paper upon the measurement of the bands of Nobert's test-plate, Mr. J. A. Brown, F.R.S., arrives at the conclusion that visibility of lines of the same width increases as the distance between them decreases; that parallel lines are least visible when there are only two, and increase in visibility with their number; that Nobert's test-lines fail as a test for the microscope, especially in the highest bands, from the incapacity of the machine to make separate lines at less intervals and of less width than $\frac{1}{180000}$ of an inch; they also fail, in all probability, on account of the faintness of the tint or shade of the lines made on the retina.—*Proceedings Royal Society*, No. 163.

MÖLLER'S PROBE-PLATTE.

Professor W. Morley, of Hudson, Ohio, has published an excellent and exhaustive article on Measurements of Möller's Diatomacean Probe-platte. In a table appended, *Navicula crassinervis* is given as having 78 to 87 striæ in 0.001 of an inch; *Nitzschia curvula*, 83 to 90; and *Amphipleura pellucida*, 92 to 95 in 0.001 of an inch. Among the causes affecting the resolvability of a given diatom the author omits one that, even in tolerably experienced hands, is of no little moment—the difficulty in securing precisely the same perfect illumination upon different occasions: a difficulty so great that Messrs. Dallinger and Drysdale have contrived a special apparatus for this purpose, and the very best attainable results, as they show, depend upon such delicate manipulations of the source of illumination, as well as its character, that it is only in the ordinary way accomplished, as one might say, by accident.—*Monthly Microscopical Journal, May*, 1876.

NOBERT'S TEST-PLATES.

Mr. W. A. Rogers, of Cambridge, already favorably known for his fine rulings on glass for micrometers, test-plates, and the diffraction spectrum, has suggested a possible explanation of Nobert's method of ruling his test-plate; assuming

the risk incurred in offering a theory which can at once be refuted by a single stroke of the pen. He divides the problem into two parts—the mechanical operation of moving the plate to be ruled over given and equal spaces, and the operation of producing on glass lines of varying degrees of fineness. After stating the difficulties in the use of a screw with divided micrometer head, and the errors to which such a screw, made and used with greatest care, is liable, he concludes that the periodicity always to be observed in these errors is due not to the screw itself, but to the mounting of the screw; the system of errors changing, when the same screw was employed, by slight movements of parts against which the screw worked; in fact, that these errors were due to unequal friction in the movements of the machine. The remedy proposed was to make the ways over which the gravity slide that carries the plate moves adjustable instead of fixed, and a nut at least half the length of the screw, four inches, instead of one, as at first. The gravity slide, having a hollow cylinder firmly attached to the under side, was placed on the ways, and the screw and its nut, passing through the cylinder, were adjusted in position, and then, the slide being firmly clamped on the ways, the space between the nut and the cylinder was filled in with plaster of Paris; it was thus in perfect adjustment for one position of the gravity slide, and any deviation in a horizontal direction could be corrected by means of the adjustable ways. The next operation is to space the lines accurately. For this purpose Mr. Rogers employed a very ingenious arrangement. A rigid arm, two feet in length, was placed so as to vibrate upon a shaft, set exactly in a line with the precision screw. At one end an electric magnet, fitted to the curvature of the head of the screw, was attached by light pivots in such a way as to give parallel motion with respect to the arm; the outer portion of the head of the screw was a rim of soft iron, operating as an armature. The other end of the arm worked between two stops, one of which was adjustable. When the circuit is completed, the magnet is attached to the head of the screw, and, by the movement of the arm from one stop to the other, is carried over a given space; the circuit being broken, the arm during the reverse movement carries the magnet without disturbing the screw. In order to guard,

however, against any disturbance, a second magnet holds the head of the screw in place while the first one is moving back. By replacing the lower stop by a wheel revolving with the screw, the latter can be made to correct its own errors by slight changes made in the periphery of the wheel. As to how Nobert rules his lines, Mr. Rogers thinks it quite evident that it is done with a diamond having a knife-edge; and he details the method employed by himself in obtaining a suitable edge. He states that certain kinds of glass will receive perfect lines only in one direction, the glass having a certain grain, as he calls it. Perhaps this is not unconnected with the "axis of rigidity" observed by Dr. Draper in constructing his glass specula for telescopes. To avoid errors from false lines, and to obtain greater distinctness, the fine lines (ruled between two heavy finding lines) should be filled with graphite, and Mr. Rogers states that the graphite of the New York Graphite Company will easily fill the finest line that can be ruled with a diamond. When the lines are thus filled, they appear with their true width and with distinct edges. The result of Mr. Rogers' experience in ruling with a knife-edge diamond is that its ruling qualities improve with use, under certain conditions. A diamond that at first would barely rule 10,000, afterward successfully ruled bands 50,000 to the inch; this does not hold good, however, of the heavier lines required for diffraction plates. The sharp, singing sound of a perfect ruling indicates to a practiced ear the nature of the cut almost as well as the sight. In attempting to fill the lines of an injured Nobert test-plate with graphite, Mr. Rogers found it impossible to do so. Subsequently he ascertained that lines ruled by himself, but with a black carbon, not only were finer and smoother than any that he had ruled before, but that they would not receive and hold graphite. He therefore concluded that Nobert's success might consist in his use of a prepared carbon, a conclusion too hastily formed so far as graphite is concerned, for afterward he found that lines ruled with the same carbon, but held at a different inclination, would receive the graphite. The best results, however, have been obtained with the prepared carbon; though it is capricious in its action, it is much harder than any other kind of diamond.—*Proceedings of the American Academy of Arts and Sciences.*

SPECTROSCOPIC EXAMINATION OF BLOOD-STAINS.

The following process for procuring a strong solution of hæmoglobin for the microscopic test of blood-stains is recommended by Dr. Richardson. Procure a glass slide with a circular excavation, and moisten the edges of the cavity with diluted glycerine. On a clean glass cover, a little larger than the cavity, deposit a very minute drop of glycerine, and in this put the tiniest fragment of a fresh-dried blood-clot; invert the slide upon the thin glass cover, and the glycerined edges of the cavity of the former will adhere to the margin of the latter, and the whole can then be put under the microscope. If only a suspected blood-spot, then two or three minute particles of the reddish substance are placed in a minute drop of a three fourths per cent. salt solution, using for this purpose tartrate of ammonium and protosulphate of iron.—*Monthly Microscopical Journal, January*, 1876.

MICROSCOPIC DETERMINATION OF BLOOD-STAINS.

The examination of supposed blood-stains, and the assertion that human blood-corpuscles can be clearly distinguished from those of the dog and guinea-pig, has stimulated observers in devising means for more readily and accurately measuring the corpuscles, and preserving them, as it were, for future study and remeasurement. Professor Gulliver, whose measurements of blood-corpuscles are those most frequently cited, has stated, in a communication on the "Sizes and Shapes of the Red Corpuscles of the Blood of Vertebrates," etc., in the Proceedings of the Zoological Society of London, June 15, 1875, that the magnitude of the corpuscles in a single species is liable to certain variations, and that in the same field of vision differences may be observed amounting to at least one third larger and smaller than the average. To lessen, as far as possible, the expenditure of time, and to furnish a means of making comparative measurements more accurately, Dr. J. J. Woodward has proposed to photograph the blood-corpuscles placed on the stage micrometer, both blood and micrometer appearing sharply defined in the picture. The measurements are to be made on the negative. He spreads the fresh blood on the micrometer, after Dr. C. Johnston's method, by means of the edge of a glass slide, and the photograph is made by

immersion objectives of high power, avoiding diffraction fringes in the images by means of a suitable condensing lens. A heliostat is not necessary to obtain good results, though Dr. Woodward recommends its use as a great time-saver, as without it the light must be readjusted for every picture. The measurements are to be made on the negative, to avoid the unequal shrinkage of paper prints. The true magnifying power is obtained by measuring the distance of the lines of the micrometer from centre to centre in the negative, and dividing by their true distance apart. Dr. Woodward states that, say twenty-five to fifty negatives, containing from 50 to 175 corpuscles each, can be made, and the corpuscles measured, in less than a quarter of the time necessary to measure the same number of corpuscles in the microscope by means of a glass eye-piece micrometer, and in less than a tenth of the time necessary if a cobweb micrometer be used, and with infinitely more accuracy. One great source of error in measuring dried blood-corpuscles has been that they have been measured in only one direction, whereas a large proportion became more or less elliptical in drying. Dr. Woodward has little faith in the claims of those who have stated or insinuated that they possess the power of discriminating human blood from that of other animals in the dried stains which are submitted to examination in criminal cases. He acknowledges, however, that the average of all the measurements of human blood that he has made is rather larger than the average of all the measurements of dog's blood; but states that it is not rare to find specimens of dog's blood in which the average size of the corpuscles is larger than that of many samples of human blood, and, indeed, on six of the thirteen negatives of dog's blood of which he furnishes tabular measurements, the average size of the corpuscles proves to be larger than the smallest average for human blood, and very diverse averages were obtained with the human and the dog's blood from different parts of the very same drop. The two tables of measurements are, of human blood, from twenty-two negatives taken from nine drops of blood, from eight individuals; and of dog's blood, from thirteen negatives from five drops of blood from a single individual; and of guinea-pig's blood, from four negatives, made from different parts of a single drop of blood.

One of these latter gave an average one millionth of an inch smaller than the smallest average for human blood; all the others gave averages larger than the smallest for human blood; and the doctor states that, in his opinion, no one could have told from the examination of this drop of blood whether it belonged to the guinea-pig, the dog, or man.—*Monthly Microscopical Journal, September*, 1876.

AIR GERMS.

The analyses of the air and other experiments made by Pasteur for the purpose of investigating the doctrine of spontaneous generation have demonstrated that the germs of inferior organisms, micrococci, bacteria, etc., are every where present in the air. In a hospital the air contains a great number of these elements, and, in addition, certain special bodies, such as pus globules and spores of epiphytic parasites, which emanate from diseased organisms, and owing to their volatility after desiccation are susceptible of hovering in the atmosphere. One square meter of the wall in the surgical ward of La Pitié having been washed, after neglect of two years, the liquid expressed from the sponge (about thirty grammes) was examined immediately afterward. It was black, and showed micrococcus in large amount, bacteria, epithelial cells, pus globules, red globules, and irregular blackish masses and ovoid bodies of unknown nature. More recently Dr. Esbeth, of Zurich, has, says the *Medical Record*, found, by the aid of the microscope, in the sweat from the face, axilla, breast, and thigh, enormous numbers of bacteria. They appear to have originated from minute bodies found upon the hairs in the mentioned regions, forming little nodules on them, and appearing as accumulations of micrococci.

POLARIZING CRYSTALS.

Mr. C. Merriman gives the following hints on "Polarizing Crystallizations." All solutions must be in distilled water, and carefully filtered. Solution of gum arabic must be added to the crystalline solution until the drops will dry on the slide without crystallizing. Then the drop on the slide is to be held over steam until one or more points of crystallization appear, then at once dried over an alcohol lamp; then held

over the steam again until the crystals have grown a trifle larger, and so on until the specimen is satisfactory. The specimens are to be first varnished over with a film of collodion, and then mounted in old Canada balsam.—*American Naturalist, May*, 1876.

ORIGIN OF THE RED CLAY OF DEEP-SEA SOUNDINGS.

Dr. Carpenter, at the Bristol meeting of the British Association, questioned the theory of Dr. Wyville Thompson on the origin of the red clay universally found in the deepest sea soundings. Dr. Thompson supposed it the residue, after the calcareous portion of the shell had been dissolved by the excess of carbonic acid, the mineral matter not calcareous left behind being a red silicate of iron; and in support of this view Dr. Thompson stated he had obtained a similar deposit of "red ash," as he terms it, from the ordinary foraminiferous ooze, after removing the calcareous portion by dilute acid. Dr. Carpenter, referring to the discovery of casts of the foraminifera in the greensands, and especially as noted by the late Professor Bailey, considers that the red clay, instead of being the ash from the foraminiferous shells, was but the higher oxidization of the iron of the internal casts, and the disintegration of them by the action of carbonic acid. The casts are formed by the decomposition of the animal, when the silicates precipitated from sea-water take the place of the animal substances, particle by particle, filling completely the cavities of these minute shells with green or ochrey silicates.

SORBY ON LIMITS OF VISION.

Mr. Sorby's address, at the annual meeting of the Royal Microscopical Society, on the ultimate limits of the microscope, as shown by the formula of Helmholtz, has elicited a reply from Count Castracane. He states that the resolution of the nineteenth band of Nobert's test-plate exceeds the limit determined by the formula, and Mr. Sorby is called upon to explain the discrepancy. Mr. Sorby does not perceive any serious difficulty in explaining on Helmholtz's principles the resolution of the band in question, and he states that it is probable, with such an illumination as that adopted by Count Castracane, that the interference fringes

would so far coincide with the true lines as not to prevent satisfactory definition; and he suggests, for the purpose of testing the theory of Helmholtz, the study of fine lines at very close but *unequal* intervals, with one or two *missed out* here and there. Theory indicates that such tests would be far more difficult to see correctly than lines ruled at regular and equal intervals.—*Monthly Microscop. Journ., July*, 1876.

BLOOD-CORPUSCLES OF THE BATRACHIA.

Professor Gulliver states that the blood-globules of the Batrachia are generally flat, or somewhat vaulted; in outline a well-defined oval, mixed occasionally with circular forms. Those of the *Amphiuma* are visible to the naked eye, and those of *Proteus* next in size—the latter thrice as large as in frogs and toads; an amount of difference of which there is no example either in the class of birds or reptiles.—*Proceedings Zool. Society, February*, 1876.

HELMHOLTZ ON LIMITS OF VISION.

In this paper it is stated that diffraction of the rays is beyond doubt the principal cause of the limitation of sharpness of the microscopical image. In comparison with diffraction, chromatic and spherical aberration appear to exert but an inconsiderable influence, in spite of the very large angles of incidence and divergence of rays. Considering the extreme care expended on calculation and execution of lenses for telescopes and the photographic camera, it is justly a matter of surprise that with the lenses of the microscope, which are so much more difficult to construct according to the prescribed dimensions, and which have so large an aperture, spherical aberration makes itself so little felt. We may add that while undoubtedly theory has very largely contributed to the perfection of the lenses for telescopes and cameras, it has hitherto done little, and, indeed, from the very nature of the case, can do comparatively little, for the perfection of the microscopical objectives. Almost all the makers of such lenses—we might say all of any note—depend upon acquired skill in the use of certain tests, *i. e.*, the artificial star, as indicating the necessary changes, in laboring toward perfection; and very seldom, we venture to say, has such perfection been the result of a rigid adherence to curves,

thicknesses, apertures, etc., previously indicated by theory. Indeed, Helmholtz himself relates the failure of an attempted improvement which he thought himself justified in inferring theoretically. The whole paper is worthy of careful study, and certainly every thing which theory can give us to aid in arriving at more satisfactory conclusions should be cordially welcomed.—*Proc. Brit. Natural. Soc., New Series*, I., *Part* 3.

PRESERVATION OF ENTOMOLOGICAL SPECIMENS.

M. Felix Plateau having recommended the use of yellow glass in the windows of rooms containing entomological collections, as a means of preserving intact the natural colors of the specimens, M. Capronnier, of the Entomological Society of Belgium, made some experiments to determine the value of this suggestion. He made five small square boxes, each covered with a pane of yellow, violet, green, blue, or colorless glass. He then fixed in the middle of each box one of the inferior wings of *Euchelia Jacobeæ*, which are of a deep carmine color, uniform in tone. Each wing was partly covered with a band of black paper, and their position was so arranged as to leave exposed successively each of the parts during a period of fifteen, thirty, and ninety days. The result was as follows: *Colorless Glass.*—The carmine tint visibly attacked after exposure of fifteen days; alteration more sensible after thirty days; after ninety days the carmine had passed into a yellowish tint. *Blue.*—The same results as with colorless glass. *Green.*—A change indicated on the thirtieth day; on the ninetieth day the alteration was marked. *Yellow.*—After ninety days the carmine color almost intact. M. Capronnier accordingly concludes that a yellowish color should be preferred in every arrangement of an entomological room.

PARTHENOGENESIS IN VERTEBRATES.

Although the phenomenon of parthenogenesis, or development of the embryo, without contact with the male element, has been of late well observed and appreciated among the invertebrates, it has been supposed that the vertebrates, as a group, formed an exception. Recent experiments by Moquin-Tandon, confirm the observations of Bischoff and Leuckart upon the eggs at least of the frog. In a recent

communication to the Academy of Science, Moquin-Tandon remarks that in the month of March last he obtained a gravid female frog, which he kept carefully away from any male; that in July the female laid a certain number of eggs, which certainly had not been impregnated in any way. He found, however, that in a number of these, although not in all, the early phases at least of segmentation occurred. He observed that, according to the usual progress, first the two large meridian circles of the egg, then the equatorial circles, were filled by the appearance of the *Faltenkranz;* but, from the development of the fourth meridian circle, sometimes even before, the breaking up assumed a very remarkable degree of irregularity, the vitelline spheres being multiplied without order, and without, possibly, a recognition of the furrows to which they owed their origin. They were of unequal size, as shown both in the lower and in the upper hemisphere. This phenomenon also occurred more rapidly than the fertilized development at the same temperature. Soon, however, this phenomenon ceased, the spheres of segmentation separated, and the entire mass went into a state of decomposition. The death period of the eggs took place at different intervals in different cases.—6 *B, August* 30, 409.

COPE'S THEORY OF EVOLUTION.

Professor Cope has restated during the past year his theory of evolution, with some emendations suggested by Haeckel. While Darwin, he says, has been the prominent advocate of the theory of evolution, it was first presented to the scientific world in a rational form by Lamarck at the beginning of the present century. Owing to the adverse influence of Cuvier, the doctrine lay dormant for half a century, and Darwin resuscitated it, making important additions at the same time. Thus Lamarck found the variations of species to be the primary evidence of evolution by descent. Darwin enunciated the law of "natural selection" as a result of the struggle for existence, in accordance with which "the fittest" only survive. This law, now generally accepted, is Darwin's principal contribution to the doctrine. It, however, has a secondary position in relation to the *origin* of variation, which Lamarck saw, but did not account

for, and which Darwin has to assume in order to have materials from which a "natural selection" can be made. Professor Cope claims that in his "Origin of Genera" it was pointed out that the most nearly related forms of animals present a relation of repression and advance, or a permanent embryonic and adult type, leaving no doubt that the one is descended from the other. This relation was termed *exact parallelism.* It was also shown that, if the embryonic form were the parent, the advanced descendant was produced by an increased rate of growth, which phenomenon was called *acceleration;* but that if the embryonic were the offspring, then its failure to attain to the condition of the parent is due to the supervention of a slower rate of growth; to this phenomenon the term *retardation* was applied. It was then shown that the *inexact parallelism* was the result of unequal acceleration or retardation. He had also shown ("Method of Creation," 1871) that the additions either appeared as *exact repetitions* of pre-existent parts, or as *modified repetitions*, the former resulting in simple, the latter in more complex organisms. Professor Haeckel, of Jena, has added the keystone to the doctrine of evolution, Cope thinks, in his *gastræa* theory. Prior to this generalization it had been impossible to determine the true relation existing between the four types of embryonic growth. But Haeckel has happily determined the existence of identical stages of growth (or segmentation) in all of the types of eggs, the last of which is the *gastrula*, and beyond which the identity ceases. Not that the four types of gastrula are without difference, but this difference may be accounted for on plain principles. In 1874 Haeckel, in his "Anthropogenie," recognized the importance of the irregularity of time of appearance of the different characters of animals during the period of growth, as affecting their permanent structure. While maintaining the view that the low forms represent the transitional stages of the higher, he proceeds to account for the want of exact correspondence exhibited by them at the present time by reference to this principle. He believes that the relation of parent and descendant has been concealed and changed by subsequent modifications of the order of appearance of characters in growth. To the original, simple descent he applies the term *palingenesis;* to the modified and later growth, *cœnogenesis.* The causes of the

changes from palingenesis to cœnogenesis he regards as three, viz., acceleration, retardation, and heterotopy.

It is clear that the two types of growth distinguished by Professor Haeckel are those which had been pointed out by Professor Cope in the "Origin of Genera" as producing the relations of "exact" and "inexact parallelism;" and that his explanation of the origin of the latter relation by acceleration or retardation is the same as that of the latter essay.—*Proc. Acad. Nat. Science, Philadelphia, Feb.*, 1876.

CEPHALIZATION A FUNDAMENTAL PRINCIPLE IN THE DEVELOPMENT OF ANIMALS.

As an example of this principle among mammals, Professor Dana says that the lowest forms are those having their locomotive functions located in the posterior parts of the body, and that in the higher the forces or force-organs are more and more forward in the structure. For example, in the whale the tail is the propelling organ, and is of enormous power and magnitude, and the brain is very small, and is situated far from the head-extremity in a great mass of flesh and bone, furnished with poor organs of sense; a grade up, in the horse or ox, the tail or posterior extremity is no longer an organ of locomotion, and is little more than a caudal whip-lash, and locomotion is performed by organs situated more anteriorly—the legs; and a well-formed head carries a brain which is a vastly higher organ of intelligence than that of the whale—but the legs are simply organs of locomotion, and the hinder are the more powerful; and higher up, in the tiger or cat, the fore-legs—not the hind-legs—are the organs of chief muscular force, and these have higher functions than that of simple locomotion; and, further, the body is proportionately shortened, and the head is shortened anteriorly, or in the jaws, and approximates thus toward the condition in man. The existence or not of a switch-like tail, as in ordinary quadrupeds, has little bearing on the question of degree of cephalization, since the organ is not an organ of locomotion, or one indicating a large posterior development of muscular force. But, approaching man in the system of life, even this seems to have significance. The principle of cephalization is believed to be fundamental, "because, first, the chief centre of nervous power or energy in an animal is at

the cephalic extremity; and, secondly, because form in nature's species is, with some limitations, an expression of force."

"We recognize, as evidence of upward progress in man, an increasing height, width and erectness of the forehead, and a shortening of his jaws, and see therein evidence of improved intellect; which means higher grade of cephalization. But, more than this, the erect form of man, the shortened arms, the naked skin, as well as the large, smooth-surfaced cranium, may also be as directly and necessarily connected with and dependent upon his superior degree of cephalization in the system of animal life; while the hairy skin, the long arms, the crested skull, the inclined posture of the man-ape, may be all involved in the ape's inferior degree of cephalization. If so, the development of the brain in man, and of all the highest structural perfections of the vertebrate type which he exhibits, is inconsistent with the existence of the hairy covering and some other circumferential as well as interior characteristics of the brute." In this article Professor Dana seems to indorse in a partial way the doctrine of evolution, remarking that "the present state of science favors the view of progress through the derivation of species from species, with few occasions for divine intervention. If then there has been derivation of species from species, we may believe that all actual struggles and rivalries among animals, leading to a 'survival of the fittest,' must tend, as in man, to progress in cephalization, and dependent structural changes. In fact, mere living, the surmounting of the daily obstacles in getting food and shelter and satisfying ordinary desires, may have given growth to the brains and structures of the Eocene mammals, aiding, but perhaps exceeding, all other influences from environments. The source of variation here pointed out is not at all at variance with Darwinism. Darwin, in fact, does not aim to explain the origin of variation among species, but chiefly the workings of natural selection—variations being in progress by some means—in leading to the 'survival of the fittest' of the varieties. Variation he refers to environments, and especially to action on the genital system. The genital system may have this prominence in plants, but for animals I would give the *nervous* system the higher place, inasmuch as upon it environments make their

first and most powerful impress."—*American Journal of Science and Arts, October*, 1876.

ORIGIN OF THE SEXES IN VEGETABLES AND ANIMALS.

Some facts tending toward an explanation of this subject have been afforded by Henneguy in his studies on the *Volvox*, a low plant. He finds that during a certain period the *Volvox* is multiplied by a sexual generation, by fission (scissiparity) of a vegetative cell, which by successive segmentations produces a colony of individuals similar to the mother-colony to which this cell belonged. But a time comes when the vegetative cell no longer possesses the property of reproducing itself thus; it can still, however, divide into segments, and give birth to a colony of little cells which acquire a sexual character; that is to say, they are incapable of living separately and of reproducing themselves. This abortive daughter-colony constitutes the male element, endowed with movement, and still enjoying a certain activity. Soon the vegetative cell becomes incapable of segmenting; it can only increase in volume: it is the female element deprived of motion, which requires, in order to reproduce itself, to fuse with the male element. Sexuality in *Volvox* appears then by degrees, the male sex appearing before the female sex as fast as the species exhausts itself by a sexual reproduction.

We must compare this fact, says Henneguy, with what takes place in the animal kingdom in those animals which are reproduced by parthenogenesis. Professor Balbiani has observed that certain Aphides and the *Phylloxeræ* degenerate when they are reproduced during a certain time by parthenogenesis; their genital and digestive organs tend to become atrophied. There is a time when the parthenogenetic individuals thus degraded give origin first to male individuals, then to female individuals, which require to be fecundated to reproduce new parthenogenetic individuals.—*Ann. Mag. of Natural History, September.*

THE BORDER-LINE BETWEEN PLANTS AND ANIMALS.

The boundary-line between animals and plants has again been effaced by the studies of Cienkowsky on a monad (*Diplophrys stercorea*). These little bodies, which he observed in moist horse-manure, multiply by division, and form, by the

union of pseudopodia, long strings, in which separate individuals can glide to and fro. In several of the organisms he examined, Cienkowsky was able to observe the taking up of solid food by the suction of algæ. Thus the boundary-lines, it is added by the commentator, a German correspondent of *Nature*, which it has so long been usual to draw between plant and animal organisms, and between the individual groups of those lowest forms of life, appear more and more illusory; and the supposition is recommended of a common lowest kingdom of organisms—that of the *Protista* of Haeckel—out of which animals and plants have by degrees been differentiated.

ARCHEBIOSIS.

The Tyndall and Bartian controversy is still *sub-judice.* The simple question is, Can air retaining all its gaseous mixtures, but self-cleansed from mechanically suspended matter, produce putrefaction? In all the various experiments made by Dr. Tyndall, when the substances were exposed to common air at a temperature of 60° to 70°, all fell into a state of putrefaction in from two to four days—not one in 600 escaped; but in no instance did air which had been proved moteless by passing a concentrated beam of light through it show the least power of producing bacterial life, or the associated phenomena of putrefaction. Both sides are preparing further experiments. Thus far, however, Dr. Tyndall has come out of the controversy with all the weight of scientific evidence and philosophic gravity of discussion on his side, while Dr. Bartian has done injury to his cause by adopting the well-known symptom of defeat, "abuse of the plaintiff's attorney."—*Brit. Med. Journal, January* 29, *February* 5 *and* 12.

EVOLUTION OF THE HORSE.

Professor Huxley devotes the sixth and last lecture of a course upon the origin of existing vertebrate animals to considering the evolution of the horse. After tracing the genealogy of the horse from Orohippus, through Paleotherium, Hipparion, etc., to Equus, the author remarks as follows: "The evidence is conclusive as far as the fact of evolution is concerned, for it is preposterous to assume that each

member of this perfect series of forms has been specially created; and if it can be proved, as the facts certainly do prove, that a complicated animal like the horse may have arisen by gradual modification of a lower and less specialized form, there is surely no reason to think that other animals have arisen in a different way. This case, moreover, is not isolated. Every new investigation into the Tertiary mammalian fauna brings fresh evidence, tending to show how the rhinoceros, the pigs, the ruminants, have come about. Similar light is being thrown on the origin of the carnivora, and also, in a less degree, on that of all the other groups of animals. It is not, however, to be expected that there should be, as yet, an answer to every difficulty, for we are only just beginning the study of biological facts from the evolutionary point of view. Still, when we look back twenty years to the publication of the 'Origin of Species,' we are filled with astonishment at the progress of our knowledge, and especially at the immense strides it has made in the region of paleontological research. The accurate information obtained in this department of science has put the *fact* of evolution beyond a doubt; formerly the great reproach to the theory was that no support was lent to it by the geological history of living things; now, whatever happens, the fact remains that the hypothesis is founded on the firm basis of paleontological evidence."

PROFESSOR MARSH'S PALEONTOLOGICAL DISCOVERIES.

Professor O. C. Marsh, in a lecture to the graduating class of Yale College, summed up the main results of his paleontological researches in the Rocky Mountains. A syllabus of the lecture is published in the *American Journal of Science*. His conclusions as to the size and growth of the brain in mammals, from the beginning of the Tertiary to the present time, may be briefly stated thus: 1. All tertiary mammals had small brains. 2. There was a gradual increase in the size of the brain during this period. 3. This increase was mainly confined to the cerebral hemispheres. 4. In some groups the convolutions of the brain have gradually become more complicated. 5. In some the cerebellum and olfactory lobes have even diminished in size. There is some evidence that the same law of brain-growth holds good

for birds and reptiles from the Cretaceous to the present time. Some additional conclusions in regard to American tertiary mammals, as far as now known, are as follows: 1. All the Ungulata from the eocene and miocene had upper and lower incisors. 2. All eocene and miocene mammals had separate scaphoid and lunar bones. 3. All mammals from these formations had separate metapodial bones. At the conclusion of the lecture, Professor Marsh announced that his work in the field was essentially completed, and that all the fossil remains collected and in part described were now in the Yale College Museum. In future he should devote himself to their study and full description, and he hoped at no distant day to make public the complete results.—*Popular Science Monthly, November.*

MIMICRY IN BUTTERFLIES EXPLAINED BY NATURAL SELECTION.

Fritz Müller, in the Jena *Zeitschrift*, endeavors to show how the phenomena of mimicry in butterflies may be explained by the theory of natural selection. He bases his inquiry upon the species of *Leptalis* found in Southern Brazil, and although, as will appear below, he adduces reasons for believing the primitive stock to have been banded, and not, like most of the family to which the genus belongs, simple white butterflies, he commences by showing how even such an extreme change could be wrought out by the survival of the fittest in the struggle for existence. "Should," he remarks, "the first unimportant variations from the original white color (of the Pierids) be useful only in attracting to their possessors, at a little shorter distance, the attention of enemies flying constantly overhead, they would become more and more useful, and cause their possessors to become continually more abundant in proportion to the type; they could therefore serve as the basis for the gradual formation of a resemblance fit to deceive even the sharp eyes of birds scanning the swarms of Ithonias (the butterflies imitated by some Leptalids) for booty." Further on he asserts that "the acceptance, as the starting-point in the origin of mimicry by natural selection, of a resemblance having its beginning at such a distance can scarcely be shaken by a single known case. It should, moreover, not escape attention that the sharp-sightedness of enemies is itself also a quality at first

gradually acquired in the struggle for existence, and one which must increase from the very fact that by protective coloring, mimicry, etc., the persecuted species escapes the less sharp-sighted pursuer. This ever-increasing sensitiveness and sharp-sightedness of the pursuer on the one hand explains the wonderful completeness of many natural imitations, and on the other makes the acceptation of an originally very slight resemblance the less hazardous."—*American Naturalist, September.*

CONVERSION OF ARTERIAL INTO VENOUS BLOOD.

A method has been proposed by Schützenberger for exhibiting the conversion of arterial into venous blood, by the deoxidation of the former by means of the absorptive power of yeast for oxygen. Thus if blood, inclosed in a thin membrane, be immersed in water mixed with yeast, and the whole exposed to a temperature of 95°, it will become venous in the course of an hour. By shaking it with air it will reabsorb oxygen, and be reconverted into arterial blood. An apparatus has been perfected upon the above principle, from which red arterial blood passed into it flows out as black venous blood, and is then again saturated with oxygen, and passed back into the apparatus.—8 *C, January* 7, 1875, 12.

DO ACIDS COAGULATE THE BLOOD?

M. Oré, inquiring whether or not acids coagulate the blood, has tried a number of curious experiments by means of subcutaneous injections. On several different occasions he injected into the veins of a dog quantities of dilute acetic acid, containing from six to twenty-five grammes of the substance itself. The treatment seemed in each case to be wholly innocuous, and no coagulation occurred. Two and a half grammes of sulphuric acid, diluted with sixty of water, injected into another dog, caused a brief panting, but no other perceptible effect. Four days later the creature was killed, but no traces of coagulation were any where to be detected in it. Somewhat similar results were furnished by the injection into various dogs of nitric, phosphoric, and chlorhydric acids, and also of alcohol. These substances, mingled with blood in free contact with the air, all cause coagulation; but in the veins no such effect is produced.—6 *B*, 1875, *Nov.* 8.

CAUSES AND MECHANISM OF THE COAGULATION OF FLUIDS.

Messrs. Matthieu and Urbain have recently made some very important experiments upon the causes and mechanism of the coagulation of fluids, particularly of the blood, which they liken to a chemical precipitation. The transformation of the soluble to an insoluble substance is produced by an acid, whose effect is generally counteracted by the alkalinities of the fluid. The acid exists in none of the normal fluids of the body except the blood. They make the following points concerning it: 1. Carbonic acid is the agent in coagulating the albumen. It only does this at an elevated temperature, because of the ammoniacal salts which must be volatilized. Cold albumen, if deprived of its ammonia, will be precipitated by the acid. 2. Carbonic acid is also the cause of the coagulation of fibrin, and blood deprived of it is incoagulable. It can not produce this effect, however, normally, because it is combined in the red globules which have a great affinity for the gas. When the organs for its excretion, viz., the lungs and the skin, do not perform their function, the acid accumulates and produces intravascular coagulation; as, for example, in death by suffocation. By a similar accumulation beyond the limit of saturation of the blood-globules in the case of ligature of a vessel coagulation is produced. Venous clots are formed in the course of debilitating diseases because of a degeneration of the red globules and loss of power to hold the acid gas. 3. Cadaveric rigidity is produced by an accumulation in the muscles of this same agent, developed by the slow oxidation of the tissues. 4. The coagulation of milk is preceded by analogous processes to those which induce the muscular coagulation of *rigor mortis;* in the former case, however, lactic acid is produced, which coagulates the casein at an ordinary temperature.

NATURE OF GASES DISCHARGED FROM THE STOMACH.

The precise nature of the gases emitted by the mouth from the stomach has not been well established, although the occurrence of that of free hydrogen is shown by the fact that they burn with a blue flame. Quite lately Ewald described the case of a person suffering from chronic gastritis, who, on lighting a cigar one day, was surprised to see this

gas take fire and burn with a yellow flame. By subjecting this to a chemical examination, it was found to consist, with other substances, of a considerable portion of marsh gas, not previously known as a product of the stomach.—18 *A*, *March* 10, 1876, 658.

PHYSIOLOGICAL ACTION OF ALCOHOL.

Dr. Lander Brunton, in a summary of a memoir before the Medical Society of London, regarding the physiological action of alcohol, states that in small quantities it increases the secretions of the gastric juice, and thus aids digestion. However unnecessary this may be in health, it is useful for the feeble and debilitated. Second, it increases the force and frequency of the pulse. Third, a large dose diminishes digestion by the too great irritation of the stomach. Fourth, it is capable of producing death by reflex action. Fifth, after absorption in the blood it diminishes the power of oxidizing the red globules of the blood. This is useful in lowering the temperature; but when this is done suddenly or very frequently it causes an accumulation of fat and a fatty degeneration of the organs. Sixth, it undergoes a sort of combustion in the organism, and maintains the increase of weight of the body. In this respect it may be considered as a food. Seventh, if taken in large doses, a portion is excreted in an unaltered condition. Eighth, it dilates the blood-vessels, increasing the force and frequency of pulsations of the heart by its action on the central nerves, and facilitates intellectual and physical action. It does not give any greater power, but renders a man capable of keeping more energy in reserve. It can thus furnish assistance to effort of short duration, but not for prolonged exercise. Ninth, it has the same effect upon the heart; but in disease alcohol frequently relaxes the pulsations of this organ instead of accelerating them, thus economizing the energy instead of wasting it. Tenth, in dilating the vessels of the skin, alcohol cools the surface at the expense of the internal organs. It is thus injurious when taken during exposure, but after such exposure it is useful as tending to prevent the congestion of the internal organs. Eleventh, the symptoms of intoxication are due to a paralysis of the nervous system; the brain and the cerebellum are first affected, then the protuberance, and finally the medulla

oblongata. Death by alcohol is generally caused by paralysis of the medulla.—12 *B*, *February* 29, 1876, 184.

NATURE OF THE INVERTEBRATE BRAIN.

Under this heading Professor Bastian describes, in a popular way, the brains of different articulated animals, beginning with those of the lowest nematoid worms and ending with those of the insects. As examples of the two extremes may be first cited that of the nematoid parasitic worm, in which what most nearly resembles a brain consists of a mere band of nerve-fibres surrounding the commencement of the œsophagus, and containing a few nerve-cells, partly between its fibres and partly in groups slightly removed therefrom. In such insects as butterflies, bees, and dragon-flies, in which the visual organs are enormously developed, and in which the power of vigorous and sustained flight is correspondingly increased, the nervous system attains its maximum of development among the *Arthropoda*. The brain of these creatures differs from that existing in all other members of the class by reason of the great development of those portions of it in relation with the visual organs. The "brain" proper in all the invertebrate animals consists properly of but a single pair of ganglia, and is in no respect homologous with the brain of the vertebrates, which consists of a number of pairs of ganglia forming a mass called the *brain*.—*Popular Science Monthly*, *October*, 1876.

ACTION OF OZONE-WATER ON THE LOWER ORGANISMS.

Herr Stein reports to the Natural History Society at Bonn that he has confirmed the observation of Dr. Geisler, that in water impregnated with ozone none of the lower organisms, either animal or vegetable, can develop; that, in fact, if they are present, they are destroyed, and without any notable evolution of gas, but the formation principally of nitric acid and its combinations. Having, however, been informed that Professor Hanstein had shown that the water-plant *Elodea Canadensis* had the remarkable power of developing oxygen, he repeated the experiment, and found that the oxygen developed by this plant had the same properties as ozone; so that this plant should no longer be called, as it is, in German, a "water pest," but rather be known by the

title of "fever destroyer." At any time swamp waters may be purified by introducing the *Elodea*, after which they become fit abodes for fishes and other animal life. — *Sitzber. Bonn*, p. 62.

THE EFFECT OF THE PRESSURE OF THE AIR UPON HUMAN LIFE.

Dr. Jourdanet, who has for many years resided at Mexico as a practicing physician, has had occasion to observe the effect upon human life of different conditions as to altitude above the sea, and has recently published, in two large volumes, an important work on this subject. In this work he has grouped together facts collected from all portions of the globe, and with much sagacity and honesty has been able to achieve something exact with respect to the effect of altitude upon human life. The fundamental principle adopted by him has been that the true nature of the effect of exterior influences is better shown by the diseases that they cause than by the healthfulness which they favor in man. After studying the influence of the oxygen of the atmosphere upon the blood, and even the diminution of temperature with increasing height above the sea, and, finally, the influence of the hygrometric state of the air, he combines all these considerations in the general study of climatic influence of high altitudes, and confirms the following law of Paul Bert for pressures of 30 inches and less: "The exercise of that faculty which animals possess of appropriating to themselves the oxygen of the atmosphere is controlled by the density of this gas, as found in the circumambient air." Death is not, then, caused by the prevailing low atmospheric pressure. It is the oxygen itself, or its pressure, exclusive of the general barometric condition, that controls the result; so that if from a pressure of 30 inches of air, one third of which is oxygen, we pass to another atmosphere with a pressure of 15 inches of air, two thirds of which is oxygen, we have conditions equally favorable to human life, since, for equal volumes of air, we find equal volumes of oxygen.—*La Aeronaute*, *Sept.*, 1875, 261.

LUBBOCK ON THE SENSES OF INSECTS.

Much has been written on the use of the antennæ of insects. That they serve as organs of touch all are agreed; but it is

almost equally clear that this is not in most cases their only function. Some entomologists regard them as auditory, some as olfactory organs. There is, however, a third alternative, which I would venture to suggest, namely, that in those insects in which the sense of hearing is highly developed they may serve as ears, while in those which have a very delicate sense of smell they may act as olfactory organs. This view is not in itself so improbable as might at first sight appear. It is evident that, in the Articulata, organs of sense are developed in various parts of the body. Whether the curious organ discovered by Müller in the metathorax of certain Orthoptera be an ear or not, it must surely be an organ of some sense. Hicks and others have described structures in the halteres and wings of insects which have all the appearance of being organs of sense; while among the Crustacea we find the remarkable case of *Mysis*, which even has an organ of sense in its tail. It is not, then, so improbable as might at first sight appear that the antennæ should in some species act as ears and in others serve for the perception of odors. The position, moreover, which they occupy renders them a most advantageous situation for an organ of sense. This suggestion would also explain various experiments and observations recorded by skillful entomologists, and which it is otherwise difficult to reconcile with one another.

Many eminent observers have regarded the antennæ as auditory organs, and have brought forward strong evidence in favor of their view. Lespés, for instance, found that a female *Locusta viridissima*, which was very sensitive to sound, lost apparently all power of hearing when the antennæ were removed. She lived a fortnight longer and continued to eat. M. Lespés observed no other result except the loss of hearing.

So far as I am aware, no proof has yet been adduced that ants possess the power of hearing. In order, if possible, to throw some light upon this interesting question, I made a variety of loud noises, including those produced by a complete set of tuning-forks, as near as possible to the ants mentioned in the preceding pages, while they were on their journeys to and fro between the nests and the larvæ. In these cases the ants were moving at a steady pace and in a most business-like manner, and any start or alteration of pace would have been at once apparent. I was never able, how-

ever, to perceive that they took the slightest notice of any of these sounds. Thinking, however, that they might perhaps be too much absorbed by the idea of the larvæ to take any notice of my interruptions, I took one or two ants at random and put them on a strip of paper, the two ends of which were supported by pins with their bases in water. The ants imprisoned under these circumstances wandered slowly backward and forward along the paper. As they did so, I tested them in the same manner as before, but was unable to perceive that they took the slightest notice of any sound which I was able to produce. I then took a large female of *F. ligniperda*, and tethered her on a board to a pin by a delicate thread about six inches in length. After wandering about for a while, she stood still, and I then tried her as before; but, like the other ants, she took no notice whatever of the sounds.

It is of course possible, however, if not probable, that ants, even if deaf to sounds which we hear, may hear others to which we are deaf. On this subject I hope to make some experiments, in which Mr. Spottiswoode has kindly promised to assist me.—*Journal of the Linnæan Society.*

THE SENSE OF SMELL IN INSECTS.

I have also made similar experiments, though with very different results, on the power of smell possessed by ants. I dipped camel's-hair brushes into peppermint-water, essence of cloves, lavender-water, and other strong scents, and suspended them about a quarter of an inch above the strips of paper along which the ants were passing in the experiments above recorded. Under these circumstances, while some of the ants passed on without taking any notice, others stopped when they came close to the pencil, and, evidently perceiving the smell, turned back. Soon, however, they returned and passed the scented pencil. After doing this two or three times, they generally took no further notice of the scent. This experiment left no doubt on my mind; still, to make the matter even more clear, I experimented with ants placed on an isolated strip of paper. Over the paper, and at such a distance as almost, but not quite, to touch any ant which passed under it, I again suspended a camel's-hair brush, dipped in assafœtida, lavender-water, peppermint-water, essence of cloves,

and other scents. In this experiment the results were very marked, and no one who watched the behavior of the ants under these circumstances could have the slightest doubt as to their power of smell.

I then took a large female of *F. ligniperda*, and tethered her on a board by a thread as before. When she was quite quiet I tried her with the tuning-forks; but they did not disturb her in the least. I then approached the feather of a pen very quietly, so as just to touch first one and then the other of the antennæ, which, however, did not move. I then dipped the pen in essence of musk and did the same; the antenna was slowly retracted and drawn quite back. I then repeated the same with the other antenna. If I touched the antenna, the ant started away, apparently smarting. I repeated the same with essence of lavender and with a second ant.—*Journal of the Linnæan Society*, 1876.

THE WEATHER AND INSECT LIFE.

The connection between insect life and the weather is remarked upon by Mr. Cotton in some notes presented to the Waterford Natural History Society. He states the occasional appearances, in unusual numbers, of any insect, are one of the greatest puzzles to entomologists, and are not in any way satisfactorily accounted for by them. Thus a pale, cloudy-yellow butterfly was very abundant in 1846, but scarce from that year until 1868, when it was positively commoner than almost any other butterfly all along the south coast of England; in some places twenty or thirty could be seen flying at once. Since that year hardly a single specimen has been seen. Probably the occurrence of a few wet or hot or cold or dry days at the time of the hatching of the larvæ of this insect determines the question as to whether the butterfly shall be common or rare during a given season.—*Transactions of the Waterford Natural History Society*, 1875, 50.

USE OF THE BATON AMONG ANCIENT EGYPTIANS AND JEWS.

F. Chabas is the author of a pamphlet upon the use of the baton among the ancient Egyptians and the Jews. All nations of the East have considered the baton not only a staff and a weapon, but a badge of authority. The same might be said of Western peoples, whose antiquities are not so

well known. The author examines into the use of the baton among these ancient nations, and gives abundant references to authorities.

SKELETONS OF PILE-DWELLING INHABITANTS.

Notwithstanding the immense number of remains of prehistoric villages and dwellings built on piles in the marshes and lakes of Central Europe, very little is known of the osteology of the builders, the burial-places having almost entirely escaped a very careful and critical search. The suggestion of the practice of cremation is met by the absence of charred bones, which would necessarily have been preserved to some extent; and immersion of the bodies in the water is disproved by the absence of any portion of the skeleton in the mud of the vicinity.

A discovery, however, has lately been made in the vicinity of one of these localities in Switzerland of a grave, which probably contains the members of a particular family. Here two large granite slabs were found, covering a chamber walled around by large vertical stone plates, and in the inclosure thus formed were found the remains of from ten to fifteen skeletons. Two skulls were in good condition; the others were fragmentary. The crania were found in the corners of the room, while the long bones were heaped up toward the middle. With these were found several perforated teeth of wild animals, a well-made axe of serpentine, bronze pins, four armlets of copper, and a bronze button.—7 *C*, III., 190.

NEW HYPOTHESIS IN REGARD TO SWISS LAKE-DWELLINGS.

A new hypothesis in regard to the lake-dwellings of Switzerland has lately been suggested to Dr. Robert by a lady, whose name he does not give. In her opinion, all or nearly all of these lake-dwellings were originally established in marshes or boggy places, selected, perhaps, on account of the comparative absence of large trees; and at this period the lakes were much extended, and much more shallow than at the present day. In the course of time, however, from various conditions, the level of these lakes became raised, and the places in which the dwellings had been established became filled with water, so as possibly either to drive out

the inhabitants or to envelop their dwellings after they had been abandoned.—3 *B*, *February* 10, 1875, 246.

DID MAN EXIST IN THE TERTIARY PERIOD OF EUROPE?

Not long ago much interest was attracted by the announcement of the discovery in the tertiary coal of Wetzikon, in Switzerland, of pieces of wood converted to coal, which, it was claimed, had been sharpened artificially by human hands; and a vastly greater antiquity was claimed for man in Europe than had been previously demonstrable. This inference, however, was seriously questioned by competent authority, who believed that some explanation other than that could be found for it; and now it is maintained with great show of plausibility that it is the work of the beaver or some other large rodent, or the rubbing together by floods of broken twigs.—19, XXIX., 274.

MAN IN THE POST-PLIOCENE OF BUENOS AYRES.

In a letter addressed by Mr. Florentine Ameghino to *Gervais's Journal of Zoology*, he communicates the discovery of large numbers of fossil bones at a depth of thirteen feet in an undisturbed quaternary bed near Mercedes, and about twenty leagues from Buenos Ayres. With these appeared great quantities of charcoal, baked clay, burned and scratched bones, arrow-points, knives and chisels of flint, and a large number of bones belonging to some fifteen species of mammalia which are for the most part extinct—among them *Holophorus ornatus*, *Holophorus burmeisteri*, *Lagostomus angustidens*, *Canis protalopex*, *Eutatus seguini*, and *Triodon mercedensis*.

In various places along the Rio Lugan, near Mercedes and Lugan, he found the bones of extinct species, worked by human hands, together with knives and stone implements of various kinds. The species identified by him are the *Mastodon humboldtii*, *Mylodon robustus*, *Ursus bonariensis*, *Pampatherium typus*, *Bos pampæus*, *Toxodon platensis*, *Lagostomus fossilis*, *Glyptodon elongatus*, *Vulpes fossilis*, *Equus curvidens*, and *Equus neogæus*.—14 *B*, IV., 526.

LAURIUM SILVER MINE.

The following statement—highly interesting if true—is now being circulated on the basis of "a letter just received

from Greece." The original Laurium Company, which almost provoked an international conflict, while working the surface at Laurium purchased the subsoil corresponding to that surface. The subsoil was not (avowedly, at least) explored, and remained unworked and unknown. Recently, however, the company, having sold the surface only to their successors, employed an engineer to examine this subsoil. His research was rewarded by the discovery of a number of wells, now filled up, which had served in ancient times for the working of the mines. In one of these mines, situated about the centre of the tract, and which appeared as though abandoned for ages, he found the miners' tools and heaps of ore about them—the mine, in short, in the very state the Greeks, surprised, doubtless, by some unexpected attack, had left it. Encouraged by this unexpected discovery, excavations were made, which are affirmed to have brought to light deposits of silver, lead, and calamine of incalculable richness. Presuming the foregoing to be true, it would disprove the current belief that these mines had been abandoned on account of their exhaustion.

FEMALE CLOTHING IN THE BRONZE PERIOD.

There is no subject at present which excites more interest than information in regard to the manners and customs of the prehistoric races of the world, any hint, however slight, being eagerly seized upon to assist in increasing our knowledge in this direction. The peculiarities of the skeletons are, of course, well known from the remains extant, the bones resisting the ordinary agencies of destruction. So with the greater portion of the implements and utensils used by these people, whether of wood, bone, stone, or metal. The case is quite different, however, in so far as human lineaments are concerned, the instances of corpses preserved, with the flesh and the skin in a better or worse state, being very rare; but when occasionally these are found, clothed, in exceptionally secure resting-places, the record of their discovery is eagerly scanned.

Quite lately, in excavating a tumulus of the bronze period in Jutland, Denmark, three oaken coffins were met with. In one was found a skeleton of a woman clothed in a woolen chemise with a long skirt. Around the loins was a girdle,

and the whole body was enveloped in a woolen cloak. Upon the head was a fillet of hair with a bronze diadem, the arm was ornamented with bracelets, and a band was around the neck, all of bronze. In the middle of the coffin was a beautiful clay vase, and a bronze dagger with a horn handle.

The skeleton of a young man was found in another coffin covered with a cloak fastened together with a pin. By the side was the scabbard of a long sword, in which was inserted a small bronze dagger. A box made of bark was near the head.

The third coffin contained the skeleton of an adult female covered with a cloak. Around the loins was fastened a short skirt of woolen tissue, with a cincture formed with twisted woolen threads, and on the head was a woolen hood.

In the same tumulus was a large square cavity inclosed by numerous stones, in which were several swords and daggers in bronze, and a double bronze button covered with gold. Under the sod which covered this tumulus was found a pile of small stones, a knife, and various other articles.—20 *B*, VI., 509.

JADE AND NEPHRITE.

An interesting volume of four hundred pages has been recently published by Professor Fischer, of Freiburg, upon the minerals jade and nephrite. These species have in themselves comparatively little of interest, and it seems at first a matter of surprise that so large a book should have been devoted to them. Their importance lies entirely in their relation to archæological matters; since the earliest times they have furnished a large part of the material employed for the carving of ornaments and idols. No localities are known for these minerals in Europe, and yet the exploration of the ancient buildings of the lake-dwellers and of similar prehistoric remains has brought to light hundreds of stone implements, both weapons and ornaments, made from these materials. It is supposed that the source was originally Siberia and Turkestan, and that they were introduced into Europe through the connections of trade. Professor Fischer describes in detail a large number of curiously carved idols, ornaments, charms, and amulets which have been obtained in part from

Eastern Asia and in part from Central America, and thus gives a very interesting chapter in archæology.

EXPLORATIONS AROUND THE NORTH CAPE.

Verkrüzen, who has been prosecuting zoological explorations in Northern Scandinavia, has lately returned to Frankfort, after an absence of three months spent in the Varsanger and other fiords, and around the North Cape. Notwithstanding the stormy weather, which interfered very greatly with his work, he succeeded in obtaining a very fine series of mollusks, of which some forms are remarkable for their size, compared with their representatives in more southern localities. He also obtained some good specimens of the winter clothing, etc., used by the Samoiedese and Finns, made from the skins of the reindeer.—13 *A*, *January* 22, 78.

EMBRYOLOGICAL DATA FOR THE CLASSIFICATION OF VERTEBRATES.

Kowalevsky was the first to show that the neural and alimentary canals communicate in the larval Ascidians, and also in the sharks and skates, as well as in the bony fishes, and in the lancelet (*Amphioxus*). It has also been observed in Amphibians by Goette, and by Kowalevsky, Owsjannikow, and Wagner in the sturgeon (*Acipenser*), and has been observed by Balfour in the sharks and skates. The latter embryologist states that "this communication between the neural and alimentary canals, which is coupled, as will be seen in the sequel, with the atrophy of a posterior segment of the alimentary canal, is a feature of great interest, which ought to throw considerable light upon the meaning of the neural canal. So far as we know, no suggestion as to the origin of it has yet been made."

The reptiles, birds, and mammals have usually been distinguished from other vertebrates by the possession of a well-developed allantois and amnion. Mr. Balfour thinks that "we may further say that the lower vertebrates, Pisces and Amphibia, are to be distinguished from the three above-mentioned groups of higher vertebrates by the positive embryonic character that their neural and alimentary canals at first communicate posteriorly. The presence or absence of this arrangement depends on the different positions

of the embryo in the blastoderm. In reptiles, birds, and mammals the embryo occupies a central position in the blastoderm, and not, as in Pisces and Amphibia, a peripheral one at its edge."—*Journal of Anatomy and Physiology, July*, 1876.

NEW HAND-BOOK OF PALEONTOLOGY.

Zittel's hand-book of Paleontology will be welcomed by a large class of students who need something broader in scope than "Science Primers," and yet without the elaborate detail of special memoirs. The division of Palæphytology is undertaken by Professor Schimper. But one part of the work, which is to be completed in two volumes, is yet published; this, however, gives abundant promise of its excellence, when complete, as a student's text-book. The illustrative wood-cuts are worthy of highest praise; and in this first part are chiefly devoted to the Rhizopoda. Though in some points the classification and treatment of the Foraminifera are open to criticism, yet this does not affect the general usefulness and value of the work.

THE SIBERIAN MAMMOTH.

In his journey up the Yenisei River, Nordenskjöld passed through the country where remains of the mammoth abound; the teeth forming an important article of commerce. They are also believed to occur on the tundras. The larger parts of the skeleton are known to be very rare, and still rarer, mammoths with flesh, hide, and hair yet remaining. It was on the peninsula between Obi and Yenisei that the great mammoth deposit discovered by Schumachoff occurred, and in the neighborhood of the same place was found the mammoth which gave occasion to Schmitt's expedition.

SUMMARY OF MARSH'S RECENT DISCOVERIES.

In a lecture by Professor Marsh to the graduating class of Yale College, delivered in the new Peabody Museum, he gave a brief *résumé* of his investigations of the fossil vertebrates of the Rocky Mountain region, referring more particularly to the cretaceous and tertiary formations. He states that within the past six years these investigations have brought to light more than three hundred fossil species of

vertebrates new to science, about two hundred of which have already been described.

Many remarkable forms of animals hitherto unknown have been revealed by Professor Marsh's researches, chief among which may be mentioned a group of birds having well-defined teeth, and constituting a new sub-class, *Odontornithes*, of two orders—one in which the teeth are in grooves, and the other in which the teeth have each a distinct socket. The former were swimmers of gigantic size, with rudimentary wings, and the vertebræ as in modern birds. The second order embraces small birds with powerful wings and biconcave vertebræ, as in *Ichthyornis*.

Another group of fossil vertebrates is that of the *Pterodactyls*, or flying reptiles, which, however, constitute a distinct order from the European. In one of these the spread of the wings amounted to twenty five feet. The class of the reptiles proved to be rich in new species, some of them lizards of sixty or more feet in length. These forms were obtained in the cretaceous formation.

The mammalia of the tertiary formation were especially interesting, among them a gigantic group of the order *Dinocerata*, nearly equal to the elephant in size, but with shorter limbs. The skull was armed with two or more pairs of horn cores, and with enormous canine tusks like those of the walrus. The brain was proportionally smaller than that of any other land mammal.

The *Tillodontia*, another new order of mammals found in the eocene deposits, possessed affinities to the carnivores, rodents, and ungulates. The remains of quadrumana were also found, related both to the lemurs of the Old World and to some of the South American monkeys. Among the eocene mammals a small hoofed animal was found, supposed to be the oldest probable ancestor of the horse. It was about as large as a fox, with four toes before and three behind. Among other mammals was a group allied to the modern rhinoceros.

Belonging to the *Brontotheridæ* is a wonderful beast, as large as the Dinocerata, having an elevated pair of horn cores on the maxillary bones; it was found among the mammals of the miocene. A small equine animal, as large as a sheep, and having three toes on each foot, with an additional

"splint" bone on those in front, was also found, thus forming an interesting miocene link in the genealogy of the horse.

Over thirty species of fossil horses were found; as also a species of rhinoceros, camels, suillines, and other large mammals, etc.—4 *D*, *July*, 1876.

HABITS OF AMERICAN FRESH-WATER RHIZOPODS.

Professor Leidy, in continuation of his studies on our American fresh-water Rhizopods, describes the habits of the genus *Hyalosphænia*, the shell of which is homogeneous and transparent. Several species have been described, one of which was discovered in the sphagnum swamps of New Jersey, and from its resemblance to a butterfly, when the pseudopods or arms are extended, it has been named *Hyalosphænia papilio*. Pores were found to exist in the shell, through which the water passes in and out as the body dilates and contracts. Foreign substances adhere to the naked *Amœbæ* on the part of the body opposite to that from whence the pseudopods are protruded. A sluggish *Amœba* had been observed to swallow shelled *Rhizopods*, and, after digesting the soft parts, the shell was ejected. Others had been observed to select specimens of diatoms having green digestible matter in their interior from those which were not possessed of such nutritive material.

MIGRATIONS OF THE LEMMING.

The remarkable migrations of the lemming in Norway have long excited the wonder of observers; the precise impulse which induces this diminutive rat to take up this journey, always in a definite direction, being a problem of very difficult solution. Mr. Duppa Crotch has propounded a new view in explanation, which is ingenious, if not entitled to consideration. As is well known, these animals always move westward in their migrations, and finally, in diminished numbers, perish in the sea. In one instance a ship is said to have sailed for fifteen minutes through an army of them, the water being literally covered as far as the eye could reach. According to Mr. Crotch, this migratory instinct is hereditary from progenitors that in a past geological age dwelt in an island of plenty now submerged beneath the Atlantic. Although there is now no land to be reached, and the goal act-

ually attained is the deep sea, it is supposed that the instinct of westward migration is inherited, and persists long after the cause of such migration has ceased to exist.—12 *A*, *June* 1, 1876, 113.

THE TRIASSIC FAUNA IN ILLINOIS.

John Collett, of the Geological Survey of Indiana, has recently discovered a number of remains of fossil vertebrata, which indicate the existence of a fresh-water formation of later age than has been heretofore supposed to exist there. The bones are those of lizards and fishes, two generic forms of each. The lizards are remarkable from their perforate vertebræ, causing them to be ring-like or tubular, as they are long or short. They represent the order *Rhynchocephalia*, which is abundant in the European trias, but is represented by only one living species, the *Sphenodon* of New Zealand. The fishes are a *Ceratodus* and a *Biplodus;* the former is also principally a genus of the trias, but, like the lizards of the same locality, has a living species in North Australia, the now famous Barrimundi. It is thus evident that the triassic fauna now represented in the southern hemisphere existed at an early geologic period not only in Europe, but in North America also.

REMAINS OF THE IRISH ELK.

Dr. A. Leith Adams communicates to *Nature* the particulars of the discovery of a large number of remains of head bones of the great Irish elk, *Cervus megaceros*, of which skeletons are now preserved in the museums of Cambridge, Yale, Philadelphia, Washington, and elsewhere in the United States. It is well known that this animal inhabited certain parts of Europe during the prehistoric period, and was especially abundant in Ireland, from which country most of the more perfect skulls and skeletons have been obtained. The frame of the animal was about the size of that of the American moose, the horns, however, much larger, although of somewhat the same shape, the distance from tip to tip in some cases being as much as twelve or fourteen feet. Zoologically the species is quite distinct.

The remains of these animals generally occur in peat bogs, and in 1847, while draining such a bog at Kellegar, among

the Dublin mountains, as many as thirty heads were obtained in a cutting of about a hundred yards in length by three in breadth. Nothing further was done in this locality until, at the suggestion of Dr. Adams, during the present year, a renewed examination of the region was made by running a series of trenches parallel with the original ditch, which was done at the expense of the Royal Irish Academy. The result has been the finding of about thirty additional heads of the great Irish deer. These were imbedded in from two to three feet of clay, often lying on or impacted between blocks of granite, as if they had been drifted into that situation. Here, as elsewhere in Ireland, they were met with around the margins of the bogs, and not in the middle, as if the animals were mired in the shallow water, or else their carcasses had drifted with the winds and currents to the sides and outlet of the lake.

Another collection of a similar character has lately been dug from a bog on the property of Mr. R. Usher, of Cappogh, near Dungarvan. These were collected in a space about one hundred yards in length and seventy in breadth, and include heads and cast antlers of no less than fifteen individuals of the great horned deer and the antler of a red deer.—12 *A*, *September* 16, 1875, 435.

REVISION OF THE GLIRES.

Mr. Edward R. Allston has lately published, in the Proceedings of the Zoological Society of London, a revision of the order of *Glires* (*Rodentia*), or gnawing animals, in which he includes both the fossil and the recent forms. The whole paper promises to be of great benefit to working naturalists, based as it is upon an examination of the principal collections of these animals in Europe.

MARSH ON THE BRONTOTHERIDÆ.

Professor Marsh published in the April number of the *American Journal of Science* an account of one of the discoveries recently made by him in regard to what he calls the *Brontotheridæ*. This is a group of gigantic mammals abounding in the lowest deposits of the miocene formation in the eastern slope of the Rocky Mountains. They were of enormous size, and so peculiar in character as not to be ref-

erable to any familiar form of modern times. They possessed horn cores, which probably sustained horns resembling those of the deer. In size they equaled the elephant, but the limbs were shorter. The nose was probably flexible, as in the tapir, but without any true proboscis. All the known remains are from points east of the Rocky Mountains, in the miocene beds of Dakota, Nebraska, Colorado, and Wyoming.—*4 D, April*, 1876.

RAPID DESTRUCTION OF THE BUFFALO.

Some idea of the extent to which the extermination of the buffalo is going on at the present time may be learned from the fact that the Wilkox Tanning Company, of Elk County, Pennsylvania, said to be the largest of the kind in the world, and which is especially engaged in tanning buffalo-skins, received in the spring of 1875 120,000 bull-buffalo hides. These were all taken within a few months previous to the time of shipment, and constituted only a small portion of the entire number destroyed, which may be safely estimated at half a million. One thousand pounds of very heavy bullets were picked out, partly imbedded in the skin or matted hair of this stock of hides. Several of these bullets were sent to the Smithsonian Institution, and were exhibited at the Centennial display, illustrating the useful products of the United States as derived from the animal kingdom.

GEOGRAPHICAL VARIATION AMONG NORTH AMERICAN MAMMALS, ESPECIALLY IN RESPECT TO SIZE.

The fourth number of the second volume of the Bulletin of the Geological and Geographical Survey of the Territories is occupied by several zoological papers by Mr. J. A. Allen, of Cambridge. The most important of these is one upon "The Geographical Variation among North American Mammals, especially in respect to Size."

Referring to the generalization that was made some years ago, that the American mammals as well as birds increase in size with the latitude of their birth-place, as also with altitude, Mr. Allen remarks that this does not apply in the case of some of the carnivora, and that the following propositions more nearly express the fact: 1. The maximum physical development of the individual is attained where the conditions

of environment are most favorable to the life of the species. 2. The largest species of a group (genus, sub-family, or family, as the case may be) are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its centre of distribution. 3. The most "typical" or most generalized representatives of a group are found also near its centre of distribution, outlying forms being generally more or less "aberrant" or specialized.

FOSSIL ELEPHANTS, DOGS, AND DEER OF NEW MEXICO.

Professor Cope has called the attention of the members of the Philadelphia Academy of Sciences to certain mammalian remains from the neighborhood of Santa Fé. The specimens exhibited belonged to the *Mastodon productus*, which must have been very abundant in that region. The speaker dwelt upon the peculiarities which distinguished it from *Mastodon Ohioticus*, and gave at length the characters of the dentition. The vertebrates found in the Santa Fé marl now number thirty-two, including eleven species of *Canis*. These are all extinct, with the exception of one species of wolf, the *Canis cœvis* of Leidy. This was believed to be identical with the living wolf, which was considered to be specifically identical with the common dog. The species mentioned originated in the Upper Miocene, and persists to the present day. A new form was described under the name of *Canis wheelerianus*. The number of species of fossil deer found in the formation spoken of was increased from four to six, the two new forms being named *Dicrocerus trilateralis* and *Dicrocerus tehuanus.—American Naturalist, October.*

NEW EXTINCT WOLF AND DEER FROM THE UPPER MISSISSIPPI.

Many years ago Professor J. D. Whitney made a collection of the bones of fossil mammals from the lead-crevices and superficial strata of the lead regions of Wisconsin, Iowa, and Illinois, a part of which were enumerated by the late Professor Jeffries Wyman in "Whitney's Geological Report of the Lead Region of the Upper Mississippi," published in 1862. The collections comprised the bones of the *Mastodon*, *Megalonyx*, and *Platygonus*, an extinct species of *Bison*, an

extinct peccary, and now Mr. J. A. Allen describes from the same collection a deer, under the name of *Cervus Whitneyi*, and a wolf, with the appellation *Canis Mississippiensis*. Nearly all these remains belong to extinct mammals and to the fauna immediately preceding the present.—*Amer. Jour. of Science and Arts*, *January*, 1876.

PROBABLE EXTINCTION OF THE ELEPHANT.

M. Hayaux du Tilly states that England alone imported annually 1,200,000 pounds of ivory, and to obtain this quantity it was necessary tó kill annually 30,000 elephants, and the ivory supply of the whole world probably caused the destruction of 100,000 elephants annually, and, as females and males were killed indiscriminately, this animal would soon become extinct.—*American Naturalist*, *November*, 1876.

A NEW CALIFORNIAN DEER.

A very pronounced variety of the mule-deer (*Cervus macrotis*) has been discovered by Judge Caton in the Sierra Nevada Range. It differs from the ordinary mule-deer chiefly in the markings of the tail, a dark line extending down the upper side of the tail uniting with the black tuft at the end, while the tail of the normal mule-deer is entirely white except a dark tuft of long hairs at the extremity.—*American Naturalist*, *August*, 1876.

A NEW PORPOISE IN NEW YORK BAY.

Under the name of *Phocœna lineata* Professor Cope describes a new species of porpoise which was taken in the harbor of New York not many months ago, and sent to the Smithsonian Institution. Under the direction of Professor Baird, a plaster cast of the animal was made and colored directly from the specimen, with the excellent result of offering a means of study more reliable than the dried skin, where the form is likely to be distorted from various causes, and the color changed by the action of the oil.—*Proc. Acad. Nat. Sci.*, *Philadelphia*, 1876.

COLORING MATTER OF THE EGGS OF BIRDS.

Mr. H. C. Sorby, who has distinguished himself by his spectroscopic and chemical investigation of the coloring

matter of leaves, has lately rendered a similar service in reference to the coloring matter of the egg of the bird, in a paper presented to the Zoological Society of London. He remarks that, although the eggs of the bird appear to be of almost unlimited variety, all this apparent confusion is due simply to a variation in the relative and total amount of a limited number of definite and well-marked substances.

Previous to his inquiry, the only suggestions made in regard to this matter of color were that the redder tints were due to altered blood, passing through the swollen vessels of the oviduct, and that both the redder and greener tints are due to bile pigments, and perhaps derived from the fæces in the cloaca. Mr. Sorby, indeed, finds good physical evidence to prove that the characteristic coloring matters in eggs are closely connected either with hæmoglobin or bile pigments, but not in the manner suggested by previous writers. He thinks that the coloring of the eggs is due to definite physiological products, and not to accidental contamination with substances whose function is altogether different.

So far Mr. Sorby has found seven well-marked substances, one identical with a coloring matter met with in nearly all groups of plants, from the lowest to the highest; the rest he has not been able to identify with any found elsewhere. All these seven substances are insoluble in water, but soluble in absolute alcohol, and sometimes in chloroform or carbon bisulphide. Some are extremely permanent, and resist the action of powerful reagents; others are so unstable that they are not only rapidly changed by acids and other agents, but are even partially decomposed by evaporating their solutions to dryness at a gentle heat.

The method adopted by Mr. Sorby in his inquiries was to actually separate the coloring matter from the shell, by various processes detailed by him, as they were subjected to various critical chemical examinations. The substances found by him are as follows:

First, *Oorhodeine.* This he considers as the most important and interesting of all the coloring matters, a very small quantity being recognized without any difficulty even when mixed with a large amount of colored impurities. It also occurs, in a larger or smaller amount, in the shells of so great a number

of eggs that its entire absence is exceptional. In a free *solid* form, as in the shell, it is generally of a peculiar brownish red.

Second, *Oocyan*. This when dissolved in alcohol is of a fine blue color. It is readily soluble in neutral alcohol, and thus can be separated from oorhodeine. It is, however, often associated with yellow substances that can not be easily removed.

Third, *Banded oocyan*. This is also of a fine blue color, but differing very decidedly in its spectrum from oocyan.

Fourth, *Yellow oöxanthine*. This may best be obtained from moderately fresh emu-eggs.

Fifth, *Rufous oöxanthine*. This, so far, has only been found in the different species of Tinamon.

Sixth, *Substance giving narrow absorption bands in the red*. This Mr. Sorby has not been able to separate in sufficient quantity to determine whether its real color is blue, green, or brown.

Seventh, *Lichnoxanthine*. This occurs in greater or less amount in almost all classes of plants, and is most especially abundant in the lichens and fungi. Mr. Sorby thinks this may possibly have been derived, to a certain degree, from the decayed vegetable matter of the nest, or, in cases of eggs which have been kept long, may be partly due to the growth of minute fungi; but, at the same time, a very closely allied, if not identical substance, does really appear to be a normal constituent of the shell of eggs having a peculiar brick-red color.

In reference to the colors of eggs, Mr. Sorby remarks that the varying tints are due to the presence of either of these primary coloring matters, and this in a separate condition, or mixed to a greater or less degree with others. Thus the various shades of green, passing from blue-green to a fine malachite-green and to a yellow-green, are due to a variable mixture of oocyan with yellow oöxanthine. It is well known that many green eggs turn blue on long keeping. This is explained by the fact that yellow oöxanthine is much more easily destroyed by oxidation resulting from exposure to light than oocyan, the oocyan or the blue color remaining unchanged.

Mr. Sorby thinks that it will be very difficult to make use

of the spectroscopic character of the coloring matter of eggs in determining their species, or even their genera, especially in view of the fact that in some eggs, as in the Guillemot, the variation in the series is so great, sometimes one tint prevailing exclusively, and in others several, or possibly all of them, combined. He concludes by stating, as a summary of his inquiries, that he considers the chief points to be that all the varied tints of birds' eggs are due to mixtures of a limited number of coloring matters having well-marked specific characters. Except in one particular case there is apparently no intimate connection between the organization of the birds and the coloring matters secreted; but if further inquiry should prove that on the whole these substances are formed naturally only during the development of the eggs of birds, it would be an important fact in relation to comparative physiology and chromatology, as showing that special colored substances are secreted under special anatomical and physiological conditions, as does indeed occur in the case of many other normal and abnormal secretions.—*Proceedings of the Zoological Society, London*, 1875, 351.

ON THE MANAGEMENT OF AQUARIA.

A valuable paper on the construction, management, and utility of aquaria, by Mr. W. Saville Kent, has been published in the Journal of the Society of Arts, in which the latest views in reference to the best mode of managing the water are brought forth. Here, as in previous communications, Mr. Kent insists upon the propriety of using the same water over and over again, especially for fresh-water tanks, urging that the perfection of the water by the deposit of all its sedimentry particles, and its more thorough combination with air and its oxygen, is better effected than by allowing a continued stream of freshly pumped sea-water or fresh water from springs.—23 *A, March* 3, 292.

PECUNIARY SUCCESS OF THE BRIGHTON AQUARIUM.

The pecuniary success of well-managed public aquaria is shown by the report of the Brighton Aquarium Company. In this it is stated that the sum of £12,310 11*s.* 7*d.* is available on dividend account. A dividend at the rate of ten per cent. per annum was paid in July last, and a second dividend

has now been ordered from the present profits, leaving a balance of £5446 to be carried forward.

The Aquarium Company has been lately the subject of proceedings in court on account of its violation of certain enactments in keeping open on Sunday. This has now been compromised by opening on Sundays during certain hours, and as an aquarium only, the other exhibitions being omitted. —2 *A*, *Feb.* 12, 1876, 134.

PHOTOGRAPHS OF THE BLOOD.

Mr. G. Gulliver, F.R.S., one of the greatest living authorities on the subject of blood corpuscles, has spoken in the highest terms of the photographs of Professor T. G. Wormley and Dr. G. Richardson, exhibiting the human blood disks compared with those of the pig, cat, dog, etc.; and he expresses the hope that American physiologists will continue these valuable representations, especially as the subject seems to be almost ignored in Europe.—*Monthly Microscopical Journal*, *July*, 1876.

CARRYING HUMBLE-BEES FROM ENGLAND TO NEW ZEALAND.

A further step in the progress of the international exchange of animals has just been made in the transmission to New Zealand, by Mr. Frank Buckland, of two nests of English humble-bees. The common English clover, which has been introduced into New Zealand and Australia, has not produced seeds in proper quantity, due, as is supposed, to the fact that, as bees perform a large portion of the labor of the fertilization of such plants, the proboscis of the common bee is not long enough to reach down to the pollen of the clover flower, which the humble-bee is enabled to do.—12 *A*, *Oct.* 14, 1875, 527.

NEW AQUARIUM AT WESTMINSTER.

The new aquarium at Westminster, which probably is justly entitled to the claim of being the largest and most magnificent establishment of the kind in existence, was opened toward the end of January for concert purposes, but the tanks were not in a condition for being filled with water. Among some special features of its construction is an arrangement that the overflow of water from one tank will

pass down a tube so as to enter the next tank at the bottom, causing a continued displacement of the water already in the tank. The reservoir, which occupies the space under the large hall, is divided into nine compartments, so that in case of accident to any part, it can be cleared of the water and repaired while the other sections remain in operation.

The total capacity of the reservoir is 600,000 gallons, and the total amount of water in the reservoir and tanks together will be 750,000 gallons. For the circulation eight rotary vulcanite pumps are erected, which are capable of sending 56,000 gallons through the tanks in an hour if needed, though it is calculated that 15,000 to 20,000 gallons will be the average amount. The salmon will have a fifty-feet run. All the pipes, culverts, etc., are of vulcanite, but the glass fronts of the tanks are fitted in cork.—*January* 27, 1875, 255.

DECREASE OF BIRDS IN MASSACHUSETTS.

There are, says Mr. J. A. Allen, few data obtainable relative to the subject of the extinction of our birds. The number of indigenous species belonging to the fauna of the state is about 310. Of these, two, the Great Auk (*Alca impennis*) and the Wild Turkey, have become wholly extirpated, and two others (the Pinnated Grouse, *Cupidonia cupido*, and the American Swan, *Cygnus americanus*) are so nearly so that the former is found at only one or two limited localities, and the latter is but a chance visitor. The Brown or Sand-hill Crane (*Grus canadensis*), and perhaps a second (the White or Whooping Crane (*Grus americanus*), were formerly inhabitants of the state, though extirpated at so early a date that they have not as yet been recognized as belonging to its fauna. Among those which have greatly decreased in numbers are the Red-winged Blackbird (*Agelæus phœniceus*), the Purple Grackle (*Quiscalus purpureus*), the Crow (*Corvus americanus*), the Raven (*Corvus corax*), the Pileated Woodpecker (*Hylotomus pileatus*), the Red-headed Woodpecker (*Melanerpes erythrocephalus*), the Wild Pigeon (*Ectopistes migratorius*), and the Snow Goose (*Anser hyperboreus*). To these, says Mr. Allen, might be added, as among those which have also notably decreased, most of the wading and swimming birds, and nearly all of the rapacious species. None of

the ducks and geese, and probably few of the limicoline species, are probably *one tenth* as numerous now as they were 250 years ago, while a great depletion has also occurred among the gulls and terns. This great diminution is, of course, not limited to the state of Massachusetts, but likewise characterizes most of the Atlantic states and some of the older states of the interior. The reduction has mainly been brought about by the destruction of forests, the progress of agriculture, and the excessive use of the gun.—*Bulletin Nuttall Ornithological Club, September.*

CATALOGUE OF ALL THE BIRDS KNOWN UP TO THIS DAY.

For three years M. Boucard has had this volume in preparation, which has been published in London. 2456 genera and 11,030 species of birds are mentioned, though he thinks a large proportion of these genera and species should be abolished. The catalogue begins with the Ostriches, as he believes that they approach most closely fossil types, while the Trochilidæ are the most recent, and perhaps the most perfect. He proposes a good many changes, among others three new orders. While he enumerates the names of leading European ornithologists from Linnæus down to Gulliver, no American name is mentioned in the preface. He says that he has examined more than 100,000 skins, and determined more than 50,000, of which he possesses the greater part.—*Journal de Zoologie*, V., No. 4.

DOMESTICATING THE PRAIRIE CHICKEN.

According to Mr. James A. Storm, of St. Josephs, prairie chickens, or pinnated grouse, are more easily tamed than any birds of his acquaintance. He has had them eat from his hand in the space of five or six days from the time they were caught. They will also breed while confined, if provided with a suitable run. He proposes this year to try the experiment of domesticating and breeding them, and thinks they can be raised to great advantage. One object of his experiment is to obtain a cross between them and the bantam. This, he thinks, will give the bantam more stamina and hardness, making it less liable to disease, as well as tending to keep it of the diminutive size so much sought after. If crossed by the Dominique bantam, he thinks the

original markings of the prairie chicken will be thereby retained.

ADDITIONAL REMAINS OF THE MOA.

It is probable that the gigantic fossil bird of New Zealand, known to the natives as the Moa, and scientifically as the *Dinornis*, *Palapteryx*, etc., will become a very common object in natural-history museums, as new discoveries of bones in large number are continually being made. The latest record is that of fifteen specimens found along the beach, about sixty miles to the north of Auckland, a more northern location than has hitherto been assigned to this group. With the bones were found several human skulls and a complete human skeleton, a rude stone hatchet, and some obsidian chips, etc., furnishing another confirmation of the well-established fact of the co-existence of the Moa with man. It will, perhaps, be remembered that among the most interesting objects in the American Museum of Natural History, in the Central Park, is a series of skeletons of this bird, procured from Dr. Julius Haast, of Christchurch, New Zealand.—12 *A*, *February* 3, 273.

THE MIGRATION OF BIRDS.

During the cold period which lasted from the 12th of December, 1874, up to the end of that month, it was remarked in England that a great number of birds belonging to species which are not in the habit of leaving their own country were found collected, as if they meditated seeking a milder climate. Unusual flights of migratory birds were equally noticed. Evidently these birds were endeavoring to escape from the temperature which was too severe for them. A comparison of the observations of naturalists with the weather-charts published in Europe and America makes it now seem certain that the weather immediately prevailing, and not that which is about to come in the near future, is the element which decides the movement of the greater number of migratory birds.

FOSSIL BIRDS IN AMERICA.

Professor Marsh continues to find objects of interest in the immense collection of fossil vertebrates gathered by himself

and his employés in the West during the past ten years. We have already referred to his discovery of a new form of pterodactyl, characterized by the entire absence of teeth, and their probable replacement by a horny sheath like that of the bill of modern birds.

He now announces two additional fossil birds possessing teeth implanted in sockets. One is a new species of the first division, *Hesperornis*, and the other forms the type of a new genus, *Lestornis* (*L. crassipes*), the remains of which indicate a large swimming bird, fully six feet in length from the bill to the end of the toes.—4 *D*, *June*, 1876.

ADDITION TO NORTH AMERICAN ORNITHOLOGY—PYRRHOPHŒNA RIEFFÈRI.

A few years ago the only species of humming-bird known with certainty to occur within the limits of the United States were the ruby-crowned, of Eastern North America, and the rufous or Nootkan hummer, of the Pacific coast. Since then quite a number of additions have been made by Mr. Xantus, Captain Feilner, Dr. Heerman, Mr. Henshaw, and others, a number of these being species occurring in Mexico, and detected across the United States border. The most recent addition of the kind is in the discovery by Dr. Merrill, of the United States army, in Texas, of *Pyrrhophœna riefferi*, taken not far from Brownsville.

There are about thirty species of humming-birds known to occur on the table-lands of Mexico, nearly all of which will be found to belong to the fauna of the United States.

THE HABITS OF BIRDS.

Ornithology has advanced greatly in this country during the past few years, and one of its longest strides has been in the direction of a knowledge of the migrations of birds, and of the causes which bring about these seasonal and united movements. But to ascertain what influences act with most force much more information is necessary, collected over wide areas and through successive seasons. *The Forest and Stream* suggests a series of points upon which observations, to be published, are especially useful and desirable. The queries are expected to bring replies that shall give the comparative abundance of birds in the observer's region, the

dates of arrival, departure, nest-building, laying of eggs, and hatching of young; the effect upon the relative abundance of particular species in retarding their arrival or hastening their departure that sudden changes of the weather, storms, and early and late seasons appear to have; and parallel notes upon the appearance of the quadrupeds, fishes, and reptiles of the region, and upon the times of flowering of plants, are also solicited. The importance of collecting such data is evident; when a sufficient amount of them is accumulated students will have the material for new advances in biology.

NEW FOSSIL GIANT BIRDS.

Professor Marsh continues his important articles upon the fossil vertebrates of the United States in a paper, printed in the *American Journal of Science*, upon the *Odontornithes*, or birds with teeth, in which he reviews the characters of certain genera, as *Hesperornis*, *Ichthyornis*, and *Apatornis*. He gives the group the rank of a sub-class characterized by the possession of teeth implanted in the jaw, and arranges them in two orders—the one, *Ichthyornithes*, with teeth in the sockets, vertebræ biconcave, sternum with keel, and wings well developed; the other, *Odontolcæ*, with teeth in grooves, vertebræ as in recent birds, sternum without keel, and wings rudimentary. The last-mentioned order has as its type the genus *Hesperornis regalis*, which was of gigantic size, the length from the apex of the bill to the end of the toes being between five and six feet. The rudimentary wings prove that flight was impossible, while the powerful swimming legs and feet were peculiarly adapted to rapid motion through the water. The tail appears to have been much expanded horizontally, as in the beaver, and doubtless was an efficient aid in diving, perhaps compensating for the want of wings, which the penguins use with so much effect in swimming under water.—4 *D*, *June.*

A TAME SERPENT.

A curious history is given by Mr. Buckland in *Land and Water* of a pet boa-constrictor, seven and a half feet in length, belonging to Mr. Mann, and which had become warmly attached to that gentleman and his wife, evincing its affection

in the most decided manner. In one instance the snake had been left for about six weeks in charge of a friend, and during this interval it was very quiet, and moped a good deal, as if missing its protectors. On their return, while still invisible to the snake, when its name was called by Mrs. Mann, it sprang forward with the greatest eagerness, and wound itself around her shoulders, caressing her in the most excited manner, and then moved to Mr. Mann, and twisted itself around him under his coat, but in neither case exerting any uncomfortable pressure.

The supposed cause of the death of this serpent is almost as curious as its manners in life, and is related by Mr. Mann as follows: During his own serious illness he was confined to his bed, and unable to respond to the caresses of the serpent. After a failure or two on its part to secure its accustomed attention, it retired to its bed, and, refusing food and water, died in a day or two, and as Mr. Mann believed verily from distress. Many interesting facts are given by Mr. Mann in regard to this remarkable serpent, who states that, although he has had many pets of different kinds, and some of them tolerably clever, he had never seen any animal that could compare with this boa for affection, quick sense, and good-humor.—2 *A*, *June* 10, 42.

NEW ORDER OF PTEROSAURIA.

Professor Marsh, in the June number of the *American Journal of Science*, gives an account of a new order of Pterosauria, or winged saurians, embracing the pterodactyls. He finds, on examination of the specimens obtained by him in 1871 and 1872, that they really are not the equivalents of the pterodactyls of Europe, as they differ therefrom in the absence of teeth. In his opinion the jaws were probably incased in a horny covering like that of the bills of birds. In several other respects the jaws of this genus are more like those of birds than of any known reptiles.

The vertebræ are similar to those of European pterosaurians, and the atlas and axis are united. There are four phalanges in the wing finger, and the metacarpal that supports it is longer than one half of the fore-arm.

The head of one of the species of this new genus, which he calls *Pteranodon longiceps*, has a length of thirty inches from

the occipital crest to the end of the premaxillary. The smallest American species is considerably less in size. The specimens referred to are from the upper cretaceous of Western Kansas. It is considered an interesting fact by Professor Marsh that the localities and geological horizon of these specialized, toothless pterodactyls are precisely the same as those of the *Odontornithes*, or birds with teeth, and the two doubtless lived together in the same region.—4 *D*, *June*, 1876.

A FOSSIL REPTILE WITH MAMMALIAN CHARACTERS IN PRINCE EDWARD ISLAND.

In a paper by Professor Owen on the former existence of Theriodont reptiles in the Ural Permian deposits as well as in South Africa, he states his belief that Leidy's *Bathygnathus borealis*, from the red sandstone, "probably of Permian age," in Prince Edward Island, was a Theriodont allied to *Lycosaurus* of the karoo beds of South Africa. Similar fossils from the Ural region had been described in 1838 by Kutorga as probably mammalian. Similar animals occurred in the conglomerates at Bristol, England.—*Ann. and Mag. Nat. Hist.*, *August.*

REPTILES OF COSTA RICA.

Professor Cope has published an important paper on the *Batrachia* and *Reptilia* of Costa Rica, with notes on the reptiles of Nicaragua and Peru, in the quarto journal of the Philadelphia Academy of Natural Sciences. Most of the Costa Rican materials were obtained from the researches of Dr. William M. Gabb, who was engaged for several years in exploring that country in behalf of the Costa Rican government, by which he has added very largely to our knowledge of the geography, geology, general natural history, and ethnology of the region. He has already published many papers in all these departments, and it is to him we owe our only reliable information in regard to the Costa Rican aborigines. The first series of all the collections made by Dr. Gabb have all been presented by him to the National Museum, in Washington, and they constitute a highly valued portion of the extensive collections of the establishment.

Other collections used by Professor Cope in this memoir are those of Dr. Van Patten and Mr. C. N. Riotti, these covering the region extending from the Atlantic to the Pacific. Eighty-nine species were furnished by Professor Gabb, of which thirty-seven were new to science. The total number of species known from all investigators in Costa Rica is one hundred and thirty-two, and it is probable that a large number yet remain to be discovered, showing that the region is rich in terrestrial cold-blooded vertebrates.

SNAKE-EATING SNAKES.

Some years ago Professor Cope described the snake-eating habits of *Oxyrrhopus plumbeus*, a large snake which was observed to have swallowed the greater part of a large *fer-de-lance*, the largest venomous snake in the West Indies. More recently a specimen was brought by Mr. Gabb from Costa Rica, almost five feet in length, which had swallowed three feet of a large harmless snake (*Herpetodryas carinatus*) about six feet in length. Still more recently Dr. J. G. Cooper records the fact that in California a garter-snake was swallowed whole by a milk-snake (*Lampropeltis boylii*). The two snakes were so nearly of a size that he did not, at a casual glance, notice any difference between them; the garter-snake was over two feet in length.—*Am. Nat., Mar. and Aug.*, 1876.

REMARKABLE HABIT OF FROGS.

Professor Peters has recently described the mode of laying its eggs employed by a species of tree-frog (*Polypedates*) from tropical Western Africa. This species deposits its eggs, as is usual among batrachians, in a mass of albuminous jelly, but instead of placing this in the water, it attaches it to the leaves of trees which border the shore and overhang a water-hole or pond. Here the albumen speedily dries, forming a horny or glazed coating of the leaf, inclosing the unimpregnated eggs in a strong envelope. Upon the advent of the rainy season the albumen is softened, and, with the eggs, is washed into the pool below, now filled with water. Here the male frog finds the masses, and occupies himself with their impregnation.

REPRODUCTION IN THE PROTEUS.

It is not a little remarkable that until recently nothing was known of the mode of reproduction of the *Proteus anguineus*, a salamander-like animal living in the subterranean waters of the caves of Carniola, in Austria, and characterized among its congeners by the absence of eyes, and as possessing other peculiarities. Quite lately, however, Mr. Franz E. Schulze has published in Kölliker's *Zeitschrift* an article on this subject, in which he remarks that while at Adelsberg in September last, he heard that the Proteus in possession of the keeper of the caves had laid eggs. He made an examination of the specimens referred to as preserved in alcohol, and then established their character by a dissection of a gravid female, and now reports that the number of eggs laid is between forty and fifty, and that they are about five millimeters in diameter. Although the eggs were kept in water after being laid by the female, no special development seems to have taken place, and consequently nothing has yet been ascertained about their interior structure. It is probable, now that attention has been directed to this subject, it will not be long before all the phenomena in regard to the species, which doubtless embrace some interesting peculiarities, will be brought to light. The egg, as represented in the drawings, is about the size of that of a salmon.—36 *C*, XXIV., 350.

HABITS OF THE MEXICAN AXOLOTL.

In a letter to Mr. Henry Lee, published in *Land and Water*, Captain Mayne Reid suggests some new ideas in regard to the occurrence of the axolotl in the lakes of Mexico. This species resembles the larval or immature condition of many American salamanders, especially those occurring under logs in damp places. Much interest has attached to this animal from the fact that, although in its native waters, at the altitude of the City of Mexico, it always remains in the larval condition, laying eggs and reproducing its kind, yet when individuals were taken to Paris, many years ago, they threw off their gills, and became transformed into true salamanders, living out of the water, and developing a totally different and much more brilliant style of coloration, with other changes in regard to the lungs, the teeth, and entire anatomy.

The special object of Captain Reid's letter was to express astonishment that descendants of the real axolotl were kept in fresh water in the Brighton Aquarium, whereas they occupy the Lake Tezcoco—a body of water so salt that even fish can not live in it.—2 *A*, *March*, 1876, 180.

SPERMATOZOA OF AMPHIUMA.

Dr. Christopher Johnston, of Baltimore, has made some interesting observations on the very large spermatozoa of *Amphiuma tridactylum*. The length of these was about $\frac{1}{83}$ of an inch. From the junction of the head with the body to the extremity of the tail was a double filament, in lively motion, so that a delicate spiral seemed to wind from the head to the caudal termination so long as the zooid was free; but the motion was instantly reversed as soon as the head became attached or entangled. When at rest, the spiral resolved itself into a most delicate, undulating membrane. The red corpuscles of the blood of the *Amphiuma* rival in size the spermatozoa, being $\frac{1}{324}$ of an inch in their larger axis, and $\frac{1}{871}$ of an inch in their conjugate diameter.—*Monthly Microscopical Journal*, *May*, 1876.

RESEMBLANCES OF PLESIOSAURS AND ICHTHYOSAURS TO OTHER VERTEBRATES.

Professor H. G. Seeley points out, in an extended article in the Journal of the Linnæan Society, not only the relation in the bones of these fossil gigantic reptiles to those of other orders of reptiles, fossil and extinct, but also their similarity in certain features to birds and even mammals.

RAFINESQUE'S FISHES OF THE OHIO.

The work of Rafinesque, entitled "Ichthyologia Ohioensis," etc., has become so rare, and his labors so generally overlooked, that Professor D. S. Jordan has published a paper in the Bulletin of the Buffalo Society of Sciences (vol. iii., No. 3, 1876), giving a list of the genera, sub-genera, and species described in this work, with the names which they should in Mr. Jordan's opinion now bear. This is of special importance, as Rafinesque's names for our fishes have priority of date over those of almost all other authors who have written on the ichthyology of our inland waters, except Lesueur.

THE PILOT FISH.

That the stories concerning this fish are true is reaffirmed by Mr. A. H. Burnell, who says that eleven years ago, while on a voyage from India to this country, his vessel was beset by many calms while crossing the "line." On one of these occasions, while some of the passengers were amusing themselves looking over the stern of the vessel, two beautiful pilot fishes (Naucrates?) were seen, and soon after a portion of an unusually large shark. Immediately a hook baited with salt pork was thrown overboard. When it touched the water these pilot fishes were seen to approach it, and then suddenly dart under the vessel. Soon a very large shark appeared and received the bait. As soon as safely secured the sailors drew him on deck. When a suitable opportunity was given for examining him, these two pilot fishes were seen attached to the body. At what particular portion they attached themselves he was unable to state. They were removed and placed in a bucket of salt water, where they swam about as if nothing had happened.—*Am. Natural.*, *Nov.*, 1876.

NEW WORK ON EUROPEAN FRESH-WATER FISHES.

Professor Von Siebold, the eminent zoologist of Munich, is about publishing a great work on the fresh-water fishes of Europe, in which he invites the co-operation of English naturalists. He also desires specimens of *Artemia salina*, or the salt-brine shrimp, for the purpose of making comparisons with the varieties of this genus found throughout the world. A work upon the fresh-water fishes of the United States, corresponding to those of Europe, is a very great desideratum, and it is much to be hoped that some of our naturalists may undertake this labor before long.—12 *A*, *March* 7, 1876, 306.

SOME CURIOUS AUSTRALIAN FISHES.

The interest that attaches to the Australian fish known as the *Ceratodus* (*C. forsteri*) is well known to naturalists. M. Castelnau, in Gervais's *Journal of Zoology*, calls attention to several other Australian species of equal interest. These are the *Neoceratodus blanchardi* and the *Osteoglossum leichardti*.

The *Ceratodus forsteri* attains a length of six feet, and its

flesh is said to be excellent and rather red, on which account it is called the Burnett salmon. It is quite restricted in its habitat, having only been met with in the Burnett and the Condamine Rivers. The *Osteoglossum leichardti* reaches a weight of twenty-five pounds. The fish is very handsome, and is taken with the hook. The *Neoceratodus blanchardi* is something like the *Ceratodus*, but differs in the structure of the teeth. It is found in the River Fitzroy, and attains a weight of from forty to ninety pounds.

The rivers in which this fish is found become almost dry at certain seasons of the year, and it is still a problem what becomes of them, although it is suggested by some that they bury in the mud, and remain there until the return of water. —14 *B*, II., 1876, 129.

POEY'S CATALOGUE OF CUBAN FISHES.

Professor Felipe Poey, the veteran Cuban ichthyologist, has recently published a catalogue of the species of that island, in which he enumerates seven hundred and thirty species. Of these, seventy-eight are considered somewhat doubtful, leaving six hundred and fifty-two. Of these, sixty-four will probably prove to be undescribed, but the determination of this will depend upon further researches and comparisons.

HABITS OF THE SALMON.

Mr. Henry Lee has lately published some of his observations on the salmon in the Brighton Aquarium in the London *Field*, which throw much light upon some of the vexed questions in regard to the natural history of this noble fish. He states that in April, 1873, nine salmon smolts, taken in the Usk River on their way to the sea, were placed in the aquarium. These were kept in tanks, some of them in fresh water, to which salt was afterward added gradually; the others were placed directly in the salt water, the latter apparently sustaining the change better than the others. Most of these fish died after a short time; two, however, remained, which were fed on shrimps and minced fish, and grew so fast that their increase was appreciable day by day. At the end of twelve months after their receipt, or, in April, 1874, only one survived, and this fish for a time ceased to grow, and was

supposed to be pining for the fresh water. It was, however, still retained in the salt water; and in May it recovered its appetite, and fattened up greatly without increasing in size. In September it again refused food, and by the middle of February, 1875, had dwindled away considerably in size and condition. Afterward it began to feed again, devouring a whole herring, chopped up for it, at a single meal.

The fish did not grow very much during the year 1875, probably requiring a larger range of water for its proper condition. The inferences derived by Mr. Lee from these facts are that smolts, going to the sea, weighing two ounces, or thereabout, return from their first migration as grilse in a little more than a year, weighing from three to five pounds; that they can exist for at least three years in the sea without ascending a river, although probably a return to the latter is necessary for its continued and more healthy growth. He also concludes that from the end of the first year to that of the fourth they feed more heartily and grow more rapidly, and are in better condition at one season than another.

Mr. Lee also remarks that the salmon never takes its food below the plane of its own position in the water, and that when shrimps and portions of fish are thrown into the tank, it will rise to meet them as they sink toward it, but will not follow any portion that has sunk below its level, nor will it feed on the bottom, in this respect being very different from the sea trout in the same tank, which rummage along the bottom for food, and pick up shrimps and pieces of fish lying there.

THE RAINBOW FISH.

The peculiarities in the nesting and hatching out of the eggs of fishes constitute one of the principal elements of interest in their study, and almost every day some variations from the established method is brought to light. One of the most remarkable instances in this respect is that presented by a small fish of the genus *Macropus*, found in the marshes and ditches along the Ganges, known in India as the *Colisa*, and called by the English the *rainbow fish*. It is characterized by its brilliant colors, and by the presence of a long filament substituted for the ventral fins. Some curious facts have lately been given by M. Carbonnier as to the nesting of

this animal. Seizing a little conferva plant with his mouth, the male raises it to the surface. Left there, the plant would sink, but the fish emits some air bubbles, and places them under it as a support. Repeating the process several times, he thus produces the first day a small floating island, about three meters in diameter. Next day he continues the supply of air, and accumulates the bubbles toward the central part, the effect being to produce a sort of dome, balanced on the surface. He then makes a rim for it with the same materials—plants and bubbles—and, going inside, he smooths and softens the interior surface. The female is then solicited to enter. The eggs are first deposited in a concave fold of the dorsal fin of the male, where they are fecundated. After laying her eggs, the female withdraws, leaving to the male fish the education of his family. He deposits the eggs with care separately in the raised part of the nest. At a later period, when he sees they need a different medium and treatment, he rises in the middle of the dome and bursts it, letting the bubbles escape, whereupon the structure flattens in the water with the imprisoned embryos, which are beginning to appear in a new stage of existence. To prevent their escape, he tears the flat rim of the nest into a sort of hanging fringe. For some time he exercises great surveillance over the progeny, till their frequent escapes and excursions announce the end of his fatigues, which occurs some eight or ten days after the flattening of the nest.—1 *B*, *Jan.* 2, 1876, 198.

INCUBATION OF CHROMIS PATERFAMILIAS.

Among the various abnormal methods of incubation, none are more curious than the habit of certain fishes of the cat-fish family of keeping the eggs in the mouth until the young are hatched, this act being generally performed by the male. Quite recently M. Lortét has added to the list the *Chromis paterfamilias*, as observed in a stream near the borders of the Sea of Tiberias, and not far from the ancient Capernaum. In this case the female deposits her eggs in a sandy depression in the bed of the stream, and the male sucks them into his mouth, and by some peculiar action causes them to be interpolated between the plates of the gills, where they are held without disturbance. The period of incubation is not mentioned, but the young, when hatched, leaving the gills, pass

forward into the cavity of the mouth, where they remain closely packed, heads forward, the cheeks of the parents swelling out as the young increase in size, and presenting a most singular appearance. A few of the young sometimes remain between the branchial plates, but most of them pass forward as stated. M. Lortét did not ascertain at what period the young left the mouth of the parent, but presumed that they remained there a considerable time. Whether, after they once leave, they re-enter for protection, is not stated. It is very remarkable that the young are not swallowed by the parent while in their receptacle.—6 *B*, *December* 13, 1875.

CAUSE OF THE BLACK SPOTS ON THE SCALES OF FISH.

The abnormal occurrence of black spots or specks upon the scales or external surface of fishes has frequently been observed, and quite often mistaken for regular coloration. Dr. Fatio, of Geneva, however, has been investigating some of these cases, and finds that in nearly all of them a small parasitic worm occupies the centre of this spot, and is easily observable by the microscope. This is inclosed in two cysts, with a peculiar liquid between, the inner being oval and transparent, and the outer round, with thick fibrous walls, outside of which is the mass of star-shaped pigment cells. The further stages of this worm have not yet been worked out, although it is quite probable that when the fish is devoured by its predaceous neighbors, this enters into another stage of the alternations of generation which have become so familiar of late years to investigators.—18 *A*, *March* 19, 1875, 10.

REMARKABLE STRUCTURE OF YOUNG FISHES.

Dr. Gunther, of London, has recently discovered that the young of the sword-fishes and chætodons possess structures exceedingly different from that of the adults. In the young chætodons the front of the body is shielded with large bony plates, which in one species are produced into three long equidistant horns, which diverge ray-like from the body. In the sword-fishes the scapular arch is prolonged into a horn at the lower part, and the belly fins are wanting. There is no sword, but the jaws are long, of equal length, and both

are furnished with teeth. As the fish grows, the scapular horn disappears, the ventral fins grow, and the upper jaw is developed in excess of the lower. The long teeth disappear, and the upper jaw grows into the toothless sword-like weapon which gives the fish its peculiar character.

CURIOUS HABITS OF FISHES.

No group of animals appears to have so many peculiarities in connection with the act of reproduction and the treatment of the eggs and young as fish, and Mr. W. Saville Kent has lately announced quite a new illustration of this fact in the London *Field*, as shown by observations made at the Westminster Aquarium upon the crested blenny of England. On one occasion his attention was attracted to certain bead-like bodies attached to the fins of one of the specimens lately received. These proved to be eggs, but it was not yet certain whether they were carried by the male or the female fish. Generally, where the eggs are protected by the parent, it is the male that assumes this duty. In the pipe-fish and sea-horse especially, the eggs, when laid by the female, are carried under the abdomen of the male until hatched.—19 *A*, *August* 19, 218.

MALE ROTIFER.

Mr. Henry Davis has succeeded in observing the male of the well-known *Conochilus volvox*. In the clear jelly in which these animals live two distinct kinds of eggs may be found—the female egg, transparent and nearly colorless; the other kind (ephippial of Huxley) somewhat larger, nearly opaque, and reticulated with dark lines within the shell; it is sometimes, though erroneously, called "winter-egg;" these are probably destined to preserve the species through the drought to which the ponds that the animals flourish in are constantly liable. A third kind, the male egg, is more rarely seen: it is transparent, showing the male neatly packed up, but even at this tender age restless and gymnastic beyond belief. The male, beyond his rarity, has little in him to admire. He is scarcely larger than the head of one of his sisters, and his constant endeavor while under the microscope is to prove himself without form and void; to simulate a preternaturally lively Amœba, and as soon as

possible to wriggle himself first to decomposition, and then to death.—*Monthly Microscopical Journal, July*, 1876.

A WRESTLING-MATCH BETWEEN ANTS AND WASPS.

New facts regarding the habits and psychology of insects are of peculiar interest nowadays. Mr. Rothney, of Bengal, describes a wrestling-match between an *Ampulex*, the destroyer of the cockroach, and some ants. On visiting a tree he was surprised to see an unusual commotion going on between these two species of insects. "All over the trunk of the tree were couples engaged in a series of struggles or wrestling-matches—wasp *versus* ant; and so many individuals were occupied in this way, and their actions were so rapid, that for some time I could make little out of their proceedings." He therefore watched the movements of a single wasp, which was evidently keeping guard over a piece of smooth bark almost eighteen inches in diameter. An ant would come on the ground and meet the wasp halfway, when, after a series of manœuvres on the part of the wasp to get her favorite hold, she would jerk the ant a clear foot off the tree, and another and another ant would be treated in the same way. "During the time I watched the tree, I saw at least twenty ants thrown, but not one wasp 'tackled.' What was most curious was the fact that all this appeared to go on without the least ill-feeling between the contending parties, and a careful examination of the defeated ants showed them to be none the worse for their falls. I watched several; on their reaching the ground they seemed to be a little bewildered, but, soon recovering themselves, made for the tree again; two, in particular, in the most plucky manner, went straight for the spot from which they had been hurled, and tried another bout with the old opponent." This would seem to corroborate Huber's statement that he saw ants wrestling and playing with one another.—*Entomologists' Monthly Magazine, September*, 1876.

THE METAMORPHOSES OF BEETLES.

M. Perris, distinguished by his works on the metamorphoses of the insects of the pine, particularly of the beetles and flies, is publishing an elaborate work on the coleopterous larvæ found in the several species of chestnut, beech, and

oak of France, particularly of the department of Landes. These three kinds of trees are closely allied, and so are the insects found upon them, many insects common to one species feeding indiscriminately upon the others; for example, almost all the beetles which live on the chestnut also prey on the oak. An important practical question is answered by Perris, whether the boring grubs of beetles attack healthy or sickly trees. Under the influence of the authority of Ratzeburg, and of facts imperfectly observed and appreciated by him, the forestry schools, and indeed the entomologists, both of Germany and France, had admitted that wood-boring insects attacked only healthy trees. But Perris insists that such insects, which make their attacks in great numbers as if acting by concert, and which consequently are very dangerous, usually only infest sickly and enfeebled trees. "This rule—for it is one—applies without exception, as I know, to insects whose larvæ pass their whole life or a part of it under the bark, namely, to those which are the more numerous and the more dangerous. The circulation of the sap in the inner layers of the bark of healthy trees, naturally very active, become still more excited by the presence of the larvæ, and thus they become smothered, as I have seen from examples thus killed." Certain beetles and other insects are an exception to this rule, such as *Compsidea*, etc., and there are species of this genus in America which destroy elm and other shade-trees while in health.—*Annales de la Soc. Linnéenne de Lyon*, 1876.

THE EYE OF FLIES.

Signor G. V. Ciaccio has published among the memoirs of the Academy of Sciences of Bologna an account of the anatomy of the eye of Diptera, describing the optic ganglion and optic nerve, the retina of which he finds composed of five coats, though still much more simple than in vertebrates. He then describes the pigment, the external envelope of the eye, and finally the tracheæ distributed to it.—*Journal de Zoologie.*

THE SEVENTEEN-YEAR CICADA.

Professor C. V. Riley has shown that there are thirteen as well as seventeen year races of this Cicada, and has pre-

dicted that "in the year 1876, and at intervals of seventeen years thereafter, they will in all probability appear from Raleigh, N. C., to near Petersburg, Virginia; in Rowan, Davie, Cabarras, and Iredell counties in North Carolina; in the valley of Virginia, as far as the Blue Ridge on the east, the Potomac River on the north, the Tennessee and North Carolina lines on the south, and for several counties west; in the south part of St. Mary's County, Maryland, dividing the county about midway east and west; in Illinois about Alton; and in Sullivan and Knox counties, Indiana." Specimens since received from Lexington, Virginia, were proof of the correctness of the prediction in regard to Virginia. While this insect requires thirteen or seventeen years, according to the race, for its underground development, the actual development has never been watched from the egg to the mature insect. In 1868 he had collected together in a particular spot near St. Louis a large number of the hatching eggs of a thirteen-year brood which will appear there again in 1881, and he had been able to obtain and note the development of the larvæ every year since. They are now (1876) about two thirds grown.—*American Naturalist, October.*

HOW COCKROACHES AND EARWIGS FOLD THEIR WINGS.

Several years ago Dr. Saussure, of Geneva, published some interesting observations on the structure of the wings of cockroaches. He treated particularly of the folding of the wings in those forms where the wing is very ample, and some contrivance necessary to insure its complete protection by the small wing-covers. The necessity of some peculiar arrangement in the winged genera of earwigs, where the extended wing is often ten times larger than the wing-covers, is even more evident, and to enable one to understand the subject Mr. S. H. Scudder gives a *résumé* of Saussure's paper, with additions of his own. In the earwig (*Forficula*) the wings are folded much as in the cockroach. The mode in which they are opened would be much more difficult to understand if it had not been observed by Charpentier, and described nearly forty years ago. The contraction of the extensor muscles attached to the hinder set of veins would undoubtedly cause the fan to expand when once the double folding, transverse and longitudinal, had been overcome; but

it does not seem possible that they could cope with this difficulty. How, then, is it done? According to Charpentier, simply by means of the forceps with which the extremity of the abdomen is always provided in both sexes; the tip of the body is bent upward and the forceps used with great rapidity and ease, first on one side and then on the other, as a sort of fingers, to bring the wings into the position which would allow the action of the thoracic muscles upon the base of the principal veins. Still, adds Mr. Scudder, it is difficult to conceive how this operation can be performed by those species whose forceps are as long as their body.—*American Naturalist, September.*

THE LIFE OF THE COMMON HOUSE-FLY.

The life of the house-fly has thus been summed up by Dr. A. S. Packard, Jun. It lives one day in the egg state, from five days to a week as a maggot, from five to seven days in the pupa state—in all, from ten to fourteen days in the month of August—before the winged adult period. It is often asked how long-lived a fly is. Most of the flies which are born in August live for a month or six weeks, and die at the coming of frost, either of cold or from the attacks of fungoid plants. A few probably winter over and survive until midsummer, and thus maintain the existence of the species. —*American Naturalist, August*, 1876.

THE PHENOMENA OF DIGESTION IN THE COCKROACH.

In a late paper on this subject, Professor Felix Plateau concludes that the food after being swallowed accumulates in the crop, where it is acted upon by the salivary fluid, which is usually alkaline. There the starchy substances are transformed into glucose; this first product of digestion is here absorbed, and is not met with in the rest of the digestive canal. The valvular apparatus, which does not play the rôle of a triturating organ, allows small quantities of the matters in process of digestion to pass into the middle intestine of limited capacity. This median intestine, or stomach, as it is usually called, receives the sugar secreted by eight glandular cæca, the sugar being ordinarily alkaline, never acid, neutralizing the acidity as the contents of the crop gradually increase, transforming the albuminoids into bodies soluble and

assimilable analogous to peptones, and emulsionizing the fatty portions. Finally in the terminal part of the intestine are reunited the residues of the work of digestion, and the secretions of the Malpighian tubes, which are purely urinary in their nature. These researches complete and confirm throughout the results of Plateau's former researches on the digestion of insects, published in 1874.—*Bulletin Academie Royale, Belgique*, XLI., 1876.

A NOISE-PRODUCING SPIDER.

Mr. Mason has exhibited to the Asiatic Society of Bengal specimens of a gigantic spider, of the genus *Mygale*, which possesses the power of making a strident noise. The sonorous organ of this animal is a comb formed by numerous elastic teeth of a chitinous nature, placed upon the lower face of the maxilla, and a scraper, composed of an irregular range of fine points on the external side of the chelicera. The apparatus is found in both sexes, as is the case with many of the coleoptera, instead of being restricted to the males, as among the orthoptera and homoptera.—14 *B*, IV., 528.

THE AFRICAN LOCUST IN GERMANY.

During the prevalent fear that the Colorado potato-bug will be introduced into Europe, an equally or even more dangerous pest has actually made its appearance in Germany in the shape of the African locust, *Acridium migratorium*, which has been found in the fields of Kerzendorf, on the Berlin and Anhalt Railway, where the insects have laid waste extensive tracts of land covered with good crops of grass and grain. Appreciating the necessity of prompt measures, however, the proprietors of the lands put a large force to work, and succeeded in destroying a great part of the insects before they could escape, digging numerous ditches and canals into which they could be swept and then covered with lime. Whether these insects laid their eggs before they were killed is of course impossible to know at present.—17 *A*, *August* 1, 1875, 117.

INEQUALITY OF THE SEXES IN A SAW-FLY.

Mr. Smith, at a late meeting of the Entomological Society of London, read some notes on *Nematus gallicola*, the gall-

maker on the leaves of species of *Salix*, of which the male had apparently not hitherto been observed. From 500 or 600 galls collected in 1875 he had obtained multitudes of females and two males; a similar result in 1876 had resulted in one male. He was of opinion that by persevering from season to season, it was possible to obtain the male of this and of other allied species of which this sex is practically unknown, though these might occur at rare intervals, the female being capable of continuing the species without (of necessity) immediate male influence.—*Ent. Monthly Mag.*, *Sept.*, 1876.

AMERICAN FOSSIL INSECTS.

A fossil cockroach and an earwig (*Labidura*) from South Park, Colorado, is described by Mr. S. H. Scudder in the Sixth Bulletin of the United States Geological Survey of the Territories.

THE ARMY WORM OF THE NORTH.

A full account of this destructive caterpillar is given by Mr. Riley in his "Eighth Annual Report on the Injurious Insects of Missouri." It is very destructive to wheat and other cereals and to grass. Living unnoticed until they are more than half an inch in length, they begin to travel in armies and devastate our fields early in August. Mr. Riley has found that the females lay their eggs in strings of fifteen or twenty along the inner base of the terminal blades where they are yet doubled. The caterpillars hatch on the eighth or tenth day after deposition, and they moult five times before turning to chrysalids.

ADULT INSECTS WITH LARVAL HEADS.

A curious research has been made by Dr. H. Hagen on a butterfly (*Morpho*) from Brazil, which, though perfect in other respects, had the head of the caterpillar instead of the butterfly's head. It seems that a few other examples of such deformities are known, viz.: four butterflies and seven moths, three beetles and one fly. The presence of the head on the winged adult seems due to the weakness of the caterpillar or larva in casting the skin, that of the head becoming adherent after that of the rest of the body has been thrown off.—*Memoirs of the Mus. Comp. Zool.*, *May*, 1876.

HATCHING SILK-WORMS BY ELECTRICITY.

Silk-worms hatched by electricity are now being reared in Italy. The superintendent of the experimental silk-worm farm at Padua has found that the hatching of silk-worms may be accelerated ten or twelve days, and a yield of forty per cent. of caterpillars secured by exposing the eggs to a current of negative electricity from a Holtz machine for eight or ten minutes. It is suggested to apply the same method to hens' eggs, and to hastening the germination of seeds.—*Popular Science Monthly, November*, 1876.

PRECOCIOUS TRANSFORMATION OF A SILK-WORM INTO THE MOTH.

In 1792 Mr. Farini, of Forli, Italy, convinced himself of the fact that caterpillars may directly transform into moths without passing through a chrysalis state. He saw two boards filled with caterpillars of *Bombyx mori* transform into moths without having spun cocoons. In 1811 he received from a correspondent two such winged specimens. Dr. Hagen adds that the fact would be a rather interesting one if it were beyond doubt. As silk-worms are raised every year by millions, it would be supposed that the observations would have been oftener made and published.—*Memoirs of the Mus. Comp. Zool., May*, 1876.

A PARASITIC MOTH.

An extraordinary case of parasitism has been noticed by Professor Westwood. The notes concerning this very unusual instance of parasitism by a moth were received by him (with specimens) twenty-six years ago from Mr. J. C. Bowring, of Hong Kong. It is a species of arctian moth, of the family of *Bombycidæ*, named *Epipycops anomala* by Bowring. The caterpillars were found attached to the dorsal surface of the *Fulgora candelaria*, the Chinese Lantern-fly, and as they grew had a cottony covering, which also occurred in the pupa state (a period very variable in duration). The whole circumstantial evidence tended to prove that it was upon the waxy secretion of the *Fulgora* that the larva fed, and that of this the cocoon of the pupa was formed.—*Entomologists' Monthly Magazine, September*, 1876.

REPRODUCTION OF THE ARMY-WORM.

An important announcement has lately been made by Professor Riley, the eminent entomologist of St. Louis, in regard to the eggs of the army-worm, *Leucania unipuncta*, in a paper lately read before the Academy of Science of that city. Dr. Riley states that at first view it seems singular that the eggs of an insect that appears in such countless myriads, from Maine to Georgia and from Virginia to Kansas, should have remained undiscovered either by farmers or entomologists. Stimulated by this rather discreditable fact, he made special efforts to solve the problem, which have been recently crowned with success by his having witnessed the mode of oviposition on the blue grass. The eggs, as he had supposed, were secreted, being either glued in rows of from five to twenty in the groove which is formed by the folding of the terminable grass blade, or in between the sheath and the stalk. Sometimes they were pushed into crevices in the ground, especially at the base of the grass stalk. The eggs are white, slightly iridescent, spherical, and only two hundredths of an inch in diameter. They are fastened to each other and to the leaf, and covered along the exposed portion by a white, glistening, viscid substance.

By the seventh day after deposition the brown head of the embryo shows distinctly through the shell. The larva hatches the eighth to the tenth day, being less than two millimeters in length, of a dull translucent white color, with a large brown-black head. On account of its extremely small size, and the color resembling the pale bases of the grass stalks near the ground, it is almost impossible to find them even where there are dozens to the square foot.—*Proc. Acad. Nat. Sc., St. Louis, May* 8, 1876, 1111.

STRUCTURE AND DEVELOPMENT OF MITES.

These animals, represented by the cheese and itch mite, are exceedingly numerous in species, and much attention has been lately paid to them, judging by the memoirs published in 1876 by French and German authors. Of the first importance is an elaborate work by A. L. Donnadieu, entitled "Recherches pour servir à l'histoire des Tétranyques," published in the *Annales de la Société Linnéenne de Lyon*, with

twelve plates. The internal anatomy and metamorphosis are quite fully given, particularly the different modes of disposition of the air-tubes and their stigmata; also the varying form of the digestive canal, which in one instance (*Tetranychus plumistoma*) sends branches even to the extremities of the feet and the palpi. In Troschel's *Archiv* there are several papers of less importance on other families of mites by Dr. Kramer.

COLORING MATTER OF THE MUREX SHELL.

MM. de Negri state that, as the result of careful investigation into the coloring matter of certain mollusks, the *Murex trunculus* contains two coloring principles, one of which is perfectly equal to indigotine. This is obtained by exposing the coloring principle of the mollusk to the air until it assumes a violet tint; then washing it with crystalline acetic acid, which dissolves the tint. Water is then added to the acetic solution, and the whole shaken up with chloroform, which dissolves the purple. The chloroform solution leaves behind, after evaporation, the residue, which is violet. Washed in ether, this is deprived of the red principle contained in it, and the remainder is redissolved in alcohol. It is well known that the ancients preferred the secretion of the *Murex brandaris* to that of the *M. trunculus.* It is found that the secretions of these two species are by no means the same, and that their products from solution are different. In fact, the secretion of *M. brandaris* is photogenic; that is to say, it does not become colored by the deprivation of light, while that of *M. trunculus* becomes violet by contact with the air. In reference to the studies of the coloring matter found in the *A. viridis*, they remark that they have found chlorophyl in other mollusks, identical with the coloring matter of vegetine.—3 *B, December* 23, 678.

EIGHTH REPORT OF THE STATE ENTOMOLOGIST OF MISSOURI.

The eighth annual report on the noxious, beneficial, and other insects of Missouri, by Charles V. Riley, state entomologist, has just been received, and, like every thing from this writer, contains much matter of interest to agriculture and entomology. The noxious species to which special attention has been directed in this report are the Colorado potato-

beetle, the canker-worm, the army-worm, the Rocky Mountain locust, and the grape-vine phylloxera. There is a special division upon innoxious insects, under which is mentioned the yucca-borer, which, according to Dr. Riley, is the only butterfly the larva of which has the boring habit. Under the head of the Colorado potato-beetle, we learn that it has become extremely abundant in the East, and that it lately swarmed to a remarkable extent on Coney Island; also, that a sprinkling of Paris green continues to be one of the most important means of preventing its ravages. From the experiments of Professors Kenzie and M'Murtrie it is shown that, contrary to the anticipations of some, there is no danger to be apprehended to the soil from the introduction of this poison. An extended article upon the Rocky Mountain locust contains the comforting assurance to the farmers of Missouri that no danger need be apprehended from it during the year 1876. In regard to the grape-vine phylloxera, which is now threatening the destruction of almost the entire system of the European vineyards, Professor Riley states that it has comparatively little effect on the American vines, and that the demand for these for exportation to Europe far exceeds the supply. Numerous well-executed wood-cuts add greatly to the interest and value of this important report.

METAMORPHOSIS OF THE CRUSTACEA.

From a study of the larvæ of thirty-eight genera of stalk-eyed crustacea, Mr. C. Spence-Bate has become convinced of the existence of a unity of character throughout the various forms and changes of crustacea; that variety in form is never inconsistent with homological truth; that parts suppressed or rendered abortive for want of use are never absolutely lost, and may be reproduced under conditions that may require them. The eyes of those crustacea, such as *Alpheus*, that inhabit dark places are reduced in power according to the condition of their habitat. But these organs are, in their larval state, as well developed, if not more so, as those of any species whose life is passed in the bright sunshine of the surface of the ocean. The blind *Deidamia*, brought from the depth of four miles below the surface of the Atlantic by the dredges of the *Challenger*, differs in no respect from *Polycheles*, taken by Heller in the comparatively shallow Adriatic

Sea. In the blind crawfish from the Mammoth Cave of America, and the sightless *Nephrops* of Formosa, the organs of vision are reduced to the smallest condition consistent with their retention; and in the Cirripedes the eyes are represented by their nervous apparatus only. No *Nauplius* form occurred. Mr. Bate believes that he has demonstrated that the three pairs of motile appendages in the Nauplius form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Dohrn, and others.—*Annals and Magazine of Natural History, August.*

INFLUENCES OF EXTERNAL AGENCIES IN ARTEMIA.

Schmankiewitsch announces an interesting fact in regard to the variation of animal species, in studying the *Artemia salina* from the salt marshes of Odessa—a crustacean known from its power of resisting the influence of concentrated brine. At the beginning of his observations, owing to the rupture of a dike, the quantity of salt in the ponds was quite small, but after repairing the concentration proceeded very rapidly, and what began as a typical *Artemia salina* was gradually modified from generation to generation, so that in a few years the animal lost its caudal lobes, and then presented all the specific characters of a second species, the *Artemia mulhausenii*.

In an inverse experiment, or passing from a greater to a less degree of concentration, the *Artemia mulhausenii* was made to return to the form of *A. salina*. In further illustration of this subject, the author gives reasons for believing that the entire genus *Artemia* is only a degraded form of *Branchipus*, a fresh-water form, changed possibly by a transfer to a saline medium.—18 *A*, *January* 9, 423.

STRANGE ISOPOD PARASITES OF THE HERMIT CRAB.

M. Hesse has described two singular parasites belonging to the Isopod *Crustacea*, and which are related to the Idotæans, but are strangely modified by their parasitic habits. In one form (*Pleurocrypta*) the parasite lives under the carapace of its host, while in the other (*Athelgue*) the dorsal surface is applied interiorly on the abdomen of the crab, and its gills are exposed on this part of its body, while the entire ani-

mal is firmly held in place by its thoracic feet.—*Annales des Sciences Naturelles, July* 15, 1876.

HABITS AND ANATOMY OF A NEREID WORM.

The habits, but more particularly the anatomy, of *Nereis virens*, a common worm found between tide marks on the coast of New England, have been studied by Mr. F. M. Turnbull. This worm grows to the length of eighteen inches or more, and is commonly met with in digging clams. It is very active and voracious, feeding on other worms, but overlooking its own immediate relatives. It suddenly thrusts out its proboscis and seizes its prey with the two powerful jaws, then withdrawing the proboscis, the jaws closing at the same time. In this way it will tear large pieces from the body of its victim, being able at one bite to cut in two a worm of its own size. The tautog, scup, and other fishes dig them out of the sand and devour them eagerly. But at certain times, especially at night, they leave their burrows, and swim about like eels or snakes, in large numbers, and at such times fall an easy prey to many kinds of fishes. This habit seems to be connected with the season of reproduction. Turnbull's account of the anatomy of the nervous and circulatory system gives the best description yet published in this country of the structure of these worms, scarcely any thing, indeed, having been accomplished in this direction by American zootomists.—*Trans. Conn. Academy, August.*

DIGESTION IN MYRIAPODS.

In an elaborate memoir of ninety-four pages in quarto, accompanied by three well-filled plates, Professor Plateau describes the anatomy, gross and minute, of the Thousand-legs and Centipedes (*Myriapoda*) of Belgium, and the phenomena of digestion. Myriapods are either carnivorous or feed on vegetable matter. The Centipedes (*Chilopoda*) feed on living animals, such as flies and mosquitoes, as in the case of the common *Lithobius*, while *Cryptops* feed on earth-worms, other myriapods (*Geophilus*), spiders, and larvæ, while allied forms devour *Poduræ*. They hold them between their jaws, and kill them by the poison which pours into the double wound produced by the points of the jaws. The effects of the poison of the *Lithobius* on the domestic fly are almost as rapid as

that of the spider. The vegetable-feeding forms (*Chilognathes*) are not poisonous. The process of digestion is carried on in the same general manner as in insects, the organs being constructed on the same plan. Plateau finds that, as in insects, the digestive liquid of Myriapods has no analogy with the gastric juice of vertebrates (its acidity in *Iulus* excepted). It does not curdle milk, emulsionate fat, nor in the carnivorous Myriapods clearly dissolve albuminoid matters. The material dissolved, salts, sugar (?), substances analogous to peptones, and emulsioned fats, pass by osmose directly through the thin walls of the stomach (there being no lacteals as in vertebrates), the surface of which is generally enormous in proportion to the size of the animal, and mixes with the blood in order to be assimilated. Plateau uses the term "salivary glands" for the glands in *Lithobius* and *Himantarium* which empty their contents into the mouth, but the fluid secreted by them is not like that of other insects and the vertebrate animals, which has the property of transforming starch into sugar, but in the two genera of Thousand-legs mentioned the fluid is colorless, neutral, or distinctly alkaline; nor is it poisonous.—*Mémoires Acad. Roy. Sc. Belgique*, 1876.

THE LARGE HUMAN FLUKE-WORM.

Dr. Cobbold thus puts in a pithy way the liability we undergo of becoming infested by parasitic worms: "Imitate the Cossacks, Burates, and Abyssinians in their fondness for raw meat, and you will be invaded by *Tæniæ;* or imitate the very similar habits of North Greenlanders in respect of fish, and you will probably enjoy the privilege of entertaining *Bothriocephali*. If you have a predilection for unfiltered water, you are likely, sooner or later, to play the *rôle* of host to some highly irritating nematode guest; or, as frequently happens in Iceland and Australia, you will be particularly likely to contract the so-called *Echinococcus* disorder." He thinks that it remains to be proved that shell-fish are altogether unconcerned in the matter of human helminthism, yet he believes that danger from this source is limited to certain mollusca living in eastern waters. About thirty years ago Professor Busk discovered fourteen large flukes in the duodenum of a Lascar. This was described under the name of *Distoma crassum*, and it was not again met with until 1874,

from two missionaries who had lived in China for about four years. In all probability it was obtained by the consumption either of fish or of shell-fish. An illustration of the rarity of parasitic worms is given by Dr. Cobbold. *Stephanurus dentatus*, a large nematode worm, was originally discovered by Natterer at Barra do Rio Negro, Brazil, in 1834. He found it infesting a Chinese variety of the common hog. It was shortly afterward described and figured by Diesing. Thirty-five years after (1869), Professor Verrill described what he very naturally supposed to be a new entozoon infesting the hogs of the United States, under the name *Sclerostoma pinguicola*. "Specimens of these worms, however, having been forwarded to me by Professor Fletcher, of Indianapolis, I at once saw that Verrill's *Sclerostomata* were the *Stephanuri* of Diesing and Natterer. Subsequently also I detected this self-same entozoon in a batch of parasites sent from Australia."—*Journal of the Linnæan Society, London.*

EMBRYOLOGY OF GASTROPODS.

Dr. N. Bobretzky, of Kiew, to whom we owe invaluable works on the developmental histories of *Astacus*, *Palæmon*, and *Oniscus*, has recently published in the *Archiv für Microscopischer Anatomie* a memoir on the embryonic development of Gastropoda. His observations relate almost exclusively to the marine forms of *Nassa*, *Natica*, and *Fusus*, and were made in Dr. Dohrn's zoological station at Naples. Six plates illustrate the work, which is remarkable for the fact that the studies of which it gives an account are the first in which the method of cutting sections has been applied to the examination of the very delicate and small eggs and embryos of Gastropod Molluscs. Dr. Bobretzky has also used and recommends a method which consists in hardening the embryo in dilute chromic acid, and then observing it under the microscope as an opaque object. Professor Ray Lankester gives an account, with excellent drawings, of the development of a pond snail, *Paludina vivipara*.—*Quar. Journal of Microscopical Science, October*, 1876.

REMARKABLE MODE OF DEVELOPMENT IN SALPA.

Dr. W. K. Brooks has discovered a most anomalous mode of development in the tunicate Salpa, which, it will be re-

membered, exists solitary and in chains. He concludes that the solitary Salpa is the female, and produces a chain of males by budding, and discharges a single egg into the body of each one of these before birth. These eggs are impregnated while the chain-salpæ are very small and sexually immature, and develop into females which give rise to males by budding. After the fœtus has been discharged from the body of the male, the latter attains its full size, becomes sexually mature, and discharges its spermatic fluid into the water to gain access to the eggs carried by other immature chains. It is worthy of notice that although Chamisso's announcement of the occurrence of alternation of generations among animals is thus seen to have been drawn from the study of animals which do not present an instance of it, this mistake has been of the greatest usefulness, since it has led to our knowledge of the numerous instances of true alternation which now form such a large and important chapter of zoological science.

The relation in which Salpa stands to the other tunicates shows also that no abrupt line can be drawn between alternation and ordinary sexual reproduction, but that they are different forms of the same process. On another occasion he attempts to show how all the strange peculiarities of Salpa receive a simple explanation upon the theory that Salpa is the descendant of an ordinary tunicate which has been modified by natural selection.—*Amer. Naturalist, November.*

STEPHANOCEROS ON SUBMERGED PLANTS.

Dr. Pierce has observed the rotifer known as the Stephanoceros growing on submerged plants near the Schuylkill River. It had not been previously noticed in that region. Dr. Pierce found that it fed on paramecia, which it seized by the extremities of its horns, and passed to its mouth by movements of the cilia which clothe them from apex to base. This Stephanoceros is inclosed for much of its length in an inflexible sheath; but at stated intervals the projected portion separates from its sheath, and swimming to another locality locates itself by the base. This Dr. Pierce observed to take place several times. He never saw any fœcal discharges from the animal, and suggests that the solid case is formed from them, and that the migration of the Stephanoceros is due to the final obstruction of this means of deposit.

GATHERING OF EUPLECTELLA.

Among the most beautiful objects in the way of natural curiosities is the now well-known *Euplectella*, or Venus's flower-basket, a cylindrical net-work resembling the finest spun glass woven together in open meshes of wonderful regularity. The *Challenger*, during her exploration, visited the single locality whence this object is obtained, off the island of Mactan, adjacent to Zebu Island, not very far from Manilla. The following account of the method of collecting it is given: "We had no sooner landed than we saw the sponges about every where, and we had no difficulty in getting a couple of fisherwomen on the following day to consent to guide us to the spot where they were found. The Indians came to us early in the morning, and we started with them in the steam-launch to the village, about six miles off, where they lived. There we took in two very curious and ingeniously contrived instruments, with which they bring the sponges up. Two long strips of bamboo meet at an angle of forty-five degrees, and are fixed in that position by an elaborate system of stays of bamboo, which are attached to a piece of wood which runs back from the angle between the two arms or wings of the machine. The piece of wood is weighted with stones, and a line is attached to it, so that the machine is pulled along on the bottom with the angle in advance and the two wings sloping backward, one on either side. The outer edge of each of the bamboo rods is armed with between thirty and forty large fish-hooks, with their barbs set forward toward the angle. The *regaderas*, as the Spaniards call them, are found at a depth of about one hundred fathoms. The Indian lets down the bamboo arrangement with a strong fine line of Manilla hemp, and pulls it slowly over the ground. Every now and then he feels a slight tug, and at the end of an hour or so he pulls it in, with usually from five to ten *regaderas* entangled in the hooks. *Euplectella* has a very different appearance, under these circumstances, from the cones of glassy net-work in the British Museum. Its silver beard is clogged with the dark gray mud in which it lives, buried to about one third of its height, and the net-work of the remainder of the tube is covered with a pall of yellowish fleshy matter, which gives it a heavier look and greatly diminishes its beau-

ty. The layer of flesh is not so thick, however, as we expected, and only slightly masks the form of even the detailed sculpture of the sponge. It is not nearly so thick and spongy as it is in another species of the same genus which we dredged off the coast of Portugal."—12 *A.*

FRUSTULIA SAXONICA.

Dr. Woodward, U. S. A., has published an article upon the markings of *Frustulia saxonica*, illustrated by copies from photographs, and correcting some misstatements and misapprehensions in a previous communication by Mr. Hickie. It will be read with interest by all those engaged in testing objectives by means of the *Diatomaceæ.—Monthly Microscopical Journal, December*, 1875.

AULACODISCUS OREGONUS.

Dr. Christopher Johnson gives a very excellent representation of *Aulacodiscus oregonus* with two centres, and he inclines to Vrolick's opinion that this and other similar monstrosities are an evidence of the action of an excessive developmental potency. It is very well known that the sporangial frustule is sometimes, in cases of conjugation of the Diatomaceæ, the result of a differentiation of the endochrome, or internal contents of a single parent frustule; and in the gemmiparous increase the division always occurs, primarily, in the central nucleus; in either case it would not be difficult to account for an occasional monstrosity.—*American Journal of Microscopy, June*, 1876.

EOZOON CANADENSE.

Mr. W. S. Dallas has translated Otto Hahn's "Micro-geological Investigation of *Eozoon Canadense.*" In this paper Hahn comes to the definite conclusion that the *Eozoon* is a myth founded on a mistaken conclusion as to the micro-geological character of certain serpentines.—*April*, 1876.

FUSISPORUM SOLARIA.

In reference to this fungus, which commonly appears on diseased potatoes in company with *Peronospora infestans*, Mr. W. G. Smith states that the resting spores are about $\frac{1}{3500}$ of an inch in diameter, and are almost always accom-

panying the oospores of *Peronospora.*—*Gardener's Chronicle*, 1876.

DIATOMS IN THE CUTICLE OF WHEAT STRAW.

Articles detailing observations of Professor P. B. Wilson, of Baltimore, have appeared in several scientific journals (as the *American Journal of Science* for May, 1876), in which it is stated that diatomaceæ, in their entire state, are absorbed by the roots of plants, and make part of the silicious cuticle of wheat straw!

This assertion has, however, been promptly met by several eminent microscopists, who show that the diatoms in the Richmond earth used in Professor Wilson's experiment are all marine, while those figured and described by him as found in wheat straw are of fresh-water forms, and probably adhered to the straw when this was pressed to the earth of the field.

CLEANING FORAMINIFERA.

Mr. C. J. Muller recommends, for the purpose of cleaning foraminifera of the chalk, a mixture with four or five times its bulk of well-washed silver sand; with this, in a proper vessel and sufficiency of water, the chalk-powder is to be shaken, say for ten minutes, and after a few minutes' rest the turbid water poured off. The operation can be repeated until the water is clear. The sand acts as a gentle rasp, removing most of the hard granular particles; and the foraminifera are finally separated by gravity from the sand.—*Monthly Microscopical Journal, May*, 1876.

BATHYBIUS.

Professor Wyville Thompson, in a letter to Mr. Huxley, says that the best efforts of the staff of the *Challenger* have failed to discover *Bathybius* in a fresh condition; and Professor Huxley states that it is seriously suspected that the thing to which he gave this name is little more than sulphate of lime precipitated in a flocculent state from the sea-water by the strong alcohol. It is much more likely that what Professor Huxley observed was the gelatinous secretion of *Diatomaceæ*, which is produced in immense abundance in the ocean depths, and which behaves, under chemical reagents,

very much like the so-called *Bathybius*. The letter will be found in *Nature*, *August* 19, 1875.

PROFESSOR T. RUPERT JONES ON THE FORAMINIFERA.

Professor T. Rupert Jones has published a paper on the variability of form in the foraminifera, especially as illustrated in the Cristellarians. The systematic grouping at present in greatest favor is based primarily on the texture of the shell, *porcellanous*, *hyaline*, or *sandy*; and, secondarily, on the arrangements of the segments of sarcode and the form of the shell chambers; and the author considers this the most natural method of grouping these extremely variable forms. While it is undoubtedly true, as Professor Williamson suggested as long ago as 1818, "that the hard shells of the foraminifera do not constitute a sufficiently constant and important element in their organization to justify our trusting to them as guides in the discrimination of species" (here referring to form rather than texture), we doubt very much whether the grouping based on texture can be any better relied upon. In the paper to which we have alluded, Professor Jones, who is, indeed, the highest authority, shows the gradual passage of these groups into each other; and he states that there are evidently several points where the differentiation of the great foraminiferal groups is by no means absolute, and that there are some general features of resemblance between all the three great groups in the style of growth and arrangement of the segments, and occasionally still more binding links. Certainly any system of classification that will do away with the unlimited multiplication of quasi-specific names, linked together by pseudo-generic titles, which can only weary the catalogue-maker and throw obstacles in the way of the systematist, should be accepted with thankfulness; but there is yet very much improvement to be made upon the system proposed by Messrs. Jones, Parker, and Brady, and we doubt, after all, whether form, with all proper allowance for possible variations from a normal type, is not at present as safe a basis for classification as shell structure. Thus the two otherwise undistinguishable genera, *Cornuspira* and *Trochammina* (as represented by *T. incerta*), are separated by the latter method, yet we are quite certain, from specimens obtained from soundings in the Bay of Campeche

by the United States steamship *Fortune*, that they pass insensibly into each other; certainly they are nowise to be distinguished in form.—*Monthly Microscop. Jour., Feb.*, 1876.

RECLAMATION BY DR. CARPENTER.

In consequence of the publication by Dr. Bessels, in the *Jenaische Zeitschrift* (vol. ix.), of a description of the animal and test of *Astrorhiza* as a new genus, Dr. Carpenter publishes an extract from a paper "On the Rhizopodal Fauna of the Deep Sea," presented to the Royal Society June 17, 1869, in which he describes this genus, which was first constituted by Dr. Sandahl in 1847, and has subsequently been considered as new by Bessels under the name *Haeckelina*. — *Quarterly Journal of Microscopical Science, May*, 1876.

PROFESSOR HUXLEY ON DEEP-SEA SOUNDINGS.

In a speech at the dinner lately given to the *Challenger's* staff, Mr. Huxley stated that the large areas of the sea-bottom covered with a kind of chalk, shells of minute creatures, have been proved beyond question remains of organisms which live at the surface, and not at the bottom—in fact, all living within one hundred fathoms of the surface. This conclusion is somewhat too sweeping. There is not the least doubt of the existence of living foraminiferæ at much greater depths; though indeed there may be myriads of free swimming forms, whose "cast-off clothes," as Mr. Huxley terms them, may aid in making the deposit. At vast depths —from 3000 to 4000 fathoms—the red clay is full of polycystinal minute sponges, and organisms with silicious skeletons. And even from some of these depths, where the abundance of carbonic acid in solution dissolves the carbonate of lime, some foraminiferal forms, with sandy tests, are living. The origin of this red clay—rich in iron and with nodules of manganese—is difficult to be explained. So marked is the character, that one after a little practice can almost judge of the depth by the color of the sounding. Many of the soundings of the *Tuscarora*, and some of them from very great depths, consisted entirely of diatom ooze, and the same was observed in the soundings of the *Challenger*. In the speech alluded to, Mr. Huxley suggests that the red clay may be decomposed pumice-stone, vomited out by volcanoes, or pos-

sibly may have something to do with that meteoric dust which is being continually rained upon us from the spaces of the universe.—12 *A*, *July* 13, 1876.

CEPHALOSIPHON AND A NEW INFUSORIAN.

Dr. C. T. Hudson concludes that the *Cephalosiphon* is a genuine Melicertan, forming its tube from early youth, and is not a temporarily incased *Philodine*, as had been supposed from having only one antenna. The new infusorian is named *Archimedea remex*, so called from its frequently assumed corkscrew shape, and from its rows of cilia used as banks of oars. The full-grown *Archimedea* is about one ninetieth of an inch in length, with a tube of one twenty-fifth of an inch, more or less, in length. It was found attached to *Anacharis alsinastrum*. The tubes are exceedingly slender, and readily deserted upon the least disturbance. They are, of course, far too long for its inhabitant, which, as a rule, lives in the top of it, though occasionally it backs down nearly to the bottom.—*Monthly Microscopical Journal, October*, 1875.

THE FRESH-WATER RHIZOPODS.

A large number of contributions to our knowledge of "Fresh-water Rhizopoda" have recently appeared in the *Archiv für Mikroscopische Anatomie*, and we condense the following from a very complete *résumé* by Mr. William Archer, who has long been known as an indefatigable student of these lively organisms. As for the name *Rhizopoda*, taken from the resemblance of the pseudopodia to the roots of a tree, it is manifestly inapplicable to the broad-lobed processes of a *Difflugia* or *Arcella*, and quite so to the flow and current of the body of an *Amœba*, or the rotating motion of a *Hyalodiscus*. Hertwig and Lisser have proposed the name *Sarcodina* (Sarcode organisms), with a division into two groups, *Monothalamia* and *Heliozoa*, and Mr. Archer's *résumé*, so far as published, relates principally to the latter.

The *Rhizopods* in question have been termed "Fresh-water *Radiolaria*." Haeckel calls them *Heliozoa*, considering them as unicellular organisms, all the true (marine) *Radiolaria* being multicellular, and, again, as not possessing a

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"central capsule," or structure homologous thereto; the rounded bodies seen in their sarcode, and sometimes regarded as a central capsule, are not to be interpreted as such; nor do they possess structures homologous to the "yellow cells of the *Radiolaria*." This is also the view of Drs. Hertwig and Lisser, in their memoir in Schulte's *Archives*, 1874, *Supp.*, and in the main of Mr. Archer. Still, as we know nothing, or at least very little, of the developmental history of the two classes, it is possible that an affinity between *Radiolaria* and *Heliozoa* may be demonstrable—demonstrated at present it is not. The *Heliozoa*, then, are an independent class of unicellular (though sometimes, rarely, multonucleated) organisms. Their fundamental form a sphere, a very few fixed by a stipes. The protoplasm, of which alone the soft part of the body is wholly composed, is differentiated into an endosarc and ectosarc, more or less pronounced. In the endosarc constantly lie the nuclei; if the nucleus (as mostly) is simple, it is more or less excentric; if there be numerous nuclei, they are irregularly scattered. The ectosarc is characterized by the possession of contractile vacuoles (not yet demonstrable in all species). The pseudopodia, serving both for the capture of nutriment and for locomotion, are thin and filiform, originating all around the superficies of the globular body; sometimes homogeneous, and sometimes granules pass along them slowly up and down. In many of the *Heliozoa* is an extremely delicate axis, passing down the pseudopodium to the endosarc as a strengthening apparatus, but not at all homologous with the spines of the *Acanthometrida*, as Greef has suggested. In the paper we have alluded to, Mr. Archer considers the two genera of the *Heliozoa Askelata*, *Actinophrys* and *Actinosphænum*. The resemblance between these is considerable, but in the former the nucleus is always single, in the latter there are numerous nuclei; in the latter the two regions, both alveolar, are distinctly marked, in the former the endosarc is homogeneous, passing by degrees into the vacuolar ectosarc.—*Quart. Jour. of Mic. Science, July*, 1876.

H. BOTANY AND HORTICULTURE.

TREE GROWTH AND THE PRESSURE OF THE BARK.

The influence of the pressure of the bark upon the structure of the annual layers of woody fibre has formed the subject of an excellent memoir by De Vries, who states that while the classic work of Nordbinger (*Der Holzring*, etc., 1870) gives a complete *résumé* of our knowledge with respect to the connection between the thickness of the annual layers and the pressure of the bark, yet, on the other hand, the phenomena connected with longitudinal incisions still remain to be considered; and he has made a long series of experiments at the Botanical Gardens at Amsterdam, in which he first has diminished artificially the pressure of the bark by longitudinal incisions; and, second, has increased the pressure artificially by enveloping the tree with a tight cord. He has been able to demonstrate, first, that the radial diameter of the woody fibres depends upon the pressure exerted by the bark during their formation; the greater the pressure the smaller the radii of the fibre. Second, the number and the size of the vessels which exist in any woody shell depends upon the pressure exerted by the bark during the formation of the shell: to a greater pressure corresponds a smaller number and a smaller diameter of the vessels.—1 *E*, XI., 1.

THE ELM OF BOSTON COMMON.

In the Transactions of the Massachusetts Horticultural Society for the year 1876, some interesting remarks are published, made on the occasion of the prostration by a gale of the ancient elm on Boston Common, which event occurred on the 15th of February. Mr. Hovey stated that one of the only two living seedlings of the Charter Oak, and which was now forty years old, was at present standing on his own grounds at Cambridge. Mr. Wilder suggests that a young tree growing very near the roots of the great elm was probably either a seedling or a sucker, and should be planted on this centennial year as a successor to the old tree. Mr.

Cruickshank stated that during the week when the Charter Oak at Hartford was prostrated, a similar event occurred to an oak in Scotland under which the Scottish hero, Sir William Wallace, had once taken refuge. The Rev. Dr. Muzzy stated that the loss of old trees touches our patriotism, and that the Washington Elm at Cambridge was even more precious than the old elm on the Common. A number of remarks were made as to the importance of caring for old trees by cutting off long, dying limbs and encouraging the vigorous buds.—*Transactions Massachusetts Horticultural Society*, 1876, 84.

ON THE ACCLIMATIZATION OF PLANTS.

Mr. G. F. Waters, in making some general remarks on acclimatizing plants, states that in Waterville, Maine, he had developed a variety of the sweet-corn, which had been grown in a rich soil, having a southeast exposure, abundantly sheltered from the north winds. In successive years its time of ripening was, at first, the middle of October, next the middle of September, next the middle of July, and the fourth year the first of August. In five years it had, therefore, shortened the period of growth from four and a half months to less than two and a quarter months, and it had frequently been gathered for the table in sixty days from planting, while the ears had shrunk from sixteen to eight rows of kernels.

In some experiments on potatoes, the freezing of the tubers before they were dug, according to his experience, seemed to shorten the period required for the maturity of the next generation. He therefore formulates a theory as follows: If to the sun's influence there be added that of the autumn's frosts, checking maturation, and holding the food elements of the embryo where they are best fitted to be taken up in the spring, then we shall have seeds which will germinate still earlier, and as their plants will be longer under the accelerating influence of the increasing heat and light of the rays of the sun, they will show better development than their progenitors. From the discussion ensuing on the reading of Mr. Waters' paper, we gather that the general experience of the members of the society was not wholly favorable to Mr. Waters' theory; Mr. Hovey and Mr. Wilder had both of them but little faith in our ability to acclimate plants indig-

enous to a very different climate.—*Transactions Massachusetts Horticultural Society*, 1876, 70.

AN AGED OAK.

Mr. Amyot gives a very interesting account of the Winfarthing Oak. He states that at the time of the Norman Conquest a forest occupied the spot now known as Winfarthing; and in the reign of Henry III. a large park, well stocked with deer, covered the spot. The old oak is said to have been called "an old oak" in the time of William the Conqueror. Nor does this seem incredible, if we compare the measurements still extant with regard to it. The tree was first measured by Mr. Marsham in 1744, when its circumference was thirty-eight feet and seven inches. Its present circumference being forty feet, shows it to have increased seventeen inches in one hundred and thirty years. In 1820 the circumference of the tree at the middle part of its trunk is stated to have been forty feet. The best estimates that can be made of its age are based upon the average growth of oak-trees in that neighborhood, and show that it can not be less than fifteen hundred years old.—*Trans. Norfolk and Norwich Nat. Soc.*, II., 12.

WAXY MATTER ON BEECH BARK.

A green felty mass, formed on the bark of beech-trees, doubtless through the agency of some insect, was investigated by Flückinger and A. Köpp. It had a greasy feel, and under the microscope exhibited thin cylindrical, bent, and twisted fibres, which readily broke up into smaller pieces. A small quantity of other undeterminable substances accompanying it gave no clew to its origin. Water had but little effect upon it, and the extract was tasteless, and without reaction on litmus. The wax extracted from the crude material with boiling bisulphide of carbon, and purified by repeated crystallizations out of its solution in the bisulphide, formed white scales, which fused at 178° to 180°. Neither its analysis nor its reactions indicated identity with Chinese wax, (Pe-la)-cerotyl-cerotate, but its composition seemed to be that of cerotic acid, obtainable from Chinese wax, although the acid reaction of the solution of cerotic acid was wanting.—18 *C*, *September* 1, 1875, 548.

THE SIZE OF FAMOUS OAKS.

The following table, compiled from data given by Amyot, will be of interest to some. It purports to give the approximate, or, if possible, the exact age, and the dimensions of some of the famous and larger oak-trees in England:

The Winfarthing Oak; circumference, 40 feet; age, 1500 years.

The smaller Winfarthing Oak; circumference, 30 feet.

The St. Edmund's Oak, at Hoxne, to which King Edmund was bound by the Danes in 870, and pierced by their arrows; circumference, 18 feet.

The twelve oaks at Brome Hall, near Diss; circumference varying from 11 feet down to 7½ feet, the average being 9 feet and 2 inches. They are all uniformly of the same age, 125 years.

Cowper's Oak; circumference, 47 feet; age, over 1500 years.

Cowthorpe Oak; circumference, 48 feet; age, 1600 years.

Leddin Oak; circumference, 30½ feet; age unknown. "Too old for naval timber" in Cromwell's time.

King's Oak at Windsor; circumference, 26 feet; age about 1000 years. "Favorite tree with William the Conqueror."

Flitton Oak; circumference, 33 feet; age, 1000 years.

Swilear Lawn Oak; circumference in 1830 was 19 feet; at present 21 feet 4 inches. "Known to have been a large tree 600 years ago." Age, 1000 years or more.

Bentley Oak; circumference in 1759, 34 feet.—*Trans. Norfolk and Norwich Nat. Soc.*, II., 11.

OAKS OF THE UNITED STATES.

According to Dr. George Engelmann (*vide* Transactions of Academy of Science, St. Louis, vol. iii., No. 3), the oaks arrange themselves into two great groups, the White oaks and the Black oaks.

"The White oaks are characterized by paler, often scaly, bark, tougher and denser wood, and sessile or subsessile stigmas, and bear the abortive ovules at the base, or rarely on the side of the perfect seed. Besides this, the leaves and their lobes or teeth are obtuse, never bristle-pointed, though sometimes spinous-tipped; their stamens are more numerous, the scales of the cup more or less knobby at base, the inner

surface of the nut glabrous or (rarely) pubescent; the fruit generally matures in the first year.

"The Black oaks have dark, furrowed bark, brittle and porous wood, styles long, and spreading or recurved, abortive ovules always near the tip of the perfect seed. The leaves and their lobes are bristle-pointed, at least in youth; lobes and teeth acute; teeth sometimes spinous. Their stamens are usually less numerous, the scales of their cup membranaceous, the inner surface of their nut always tomentose; the fruit generally matures in the second year."

HETEROMORPHISM IN EPIGÆA.

Fruit is seldom met with in *Epigæa repens*, or common Mayflower. In the *American Journal of Science* Professor Asa Gray calls attention to the heteromorphic states of the flowers as follows:

"There are four kinds of flowers: the *first*, with long style and perfect stigma; the *second*, with perfect stigma likewise, but shorter style. Both have more or less abortive anthers lower than the stigmas. These two forms amounted together to less than twenty per cent. of a large number of specimens from one locality in Maine. In the *third* form, with longer style than No. 1, but imperfect stigma, the anthers abound with pollen, and are dehiscent at or a little before the opening of the corolla. The *fourth* has a shorter style, with the imperfect stigma as low as the base of the five longer anthers, otherwise as in No. 3. The flowers of *Epigæa* may therefore be classified into two kinds, each with two modifications: the two main kinds characterized by the nature and perfection of the stigma, along with more or less abortion of the stamens; their modifications by the length of the style. The first is leading to diœcism, the second points to dimorphism, a singular fact among *Ericaceæ*, which usually secure intercrossing by dichogamy, *i. e.*, by developing the anthers before or after the stigma."

GROUPING OF ZOOSPORES IN WATER.

When zoospores are swimming about in water, they frequently collect in masses of different shapes, but generally of some symmetrical form. This was supposed to be owing to the action of the light; but Sachs shows that it has nothing

to do with the influence of light, but is dependent on currents in the water caused by differences of temperature in different parts of the fluid. He was able to produce similar figures by making an emulsion of oil, colored red with henna, with a mixture of alcohol and water. Sachs divides the figures formed into two classes, the polarized and the concentric. The former are formed when the opposite sides of the vessel containing the emulsion are unequally heated; the latter when the temperature is uniform. The fact that microzoospores appear to collect on the side of the vessel containing them which is toward the light, and the macrozoospores toward the dark side, is accounted for by Sachs by the fact that the macrozoospores, being heavier than the microzoospores, sink to the bottom, and consequently, inasmuch as the current on the surface of a fluid and that on the bottom are in opposite directions, they would be carried in the opposite direction from the microzoospores, which are near the surface.

AN INTOXICATING GRASS.

"Besides the 'Dronk' grass, *i. e.*, Drunk Grass, of the Dutch colonists in South Africa, it now appears that there is in Mongolia another plant with a corresponding native name and similar properties. It proves to be a new species of *Stipa*, brought from the Alachan Mountains by a Roman Catholic missionary, whose horses were disabled by its inebriating properties. The wandering Mongols of the region are familiar with this grass, and use vinegar as an antidote."—*American Journal of Science.*

SELF-BURYING SEEDS.

The essential points of structure common to all self-burying seeds are: (1) A sharp point more or less covered with reflexed hairs; (2) a strong woody awn, bent sharply at one point, so as to be divided into a lower vertical and an upper more or less horizontal part, the vertical part being strongly twisted on its own axis (or forming a helix, as in the Geraniaceæ). The hygroscopic phenomena exhibited by all the seeds are: (1) On being wetted the vertical part of the awn untwists, and causes the straight horizontal part to revolve and describe a circle in a horizontal plane; the angle between the

vertical and horizontal parts also gradually disappears, and the awn becomes straight; (2) as the awn becomes dry again, the movements just described are reversed, the angular bend and the torsion of the lower part of the awn appearing. What special advantage it may be to a plant that its seeds should be buried is uncertain; in the case of Stipa, at least, it seems to have no connection with germination; it is conjectured that it may serve as a protection against graminivorous birds, etc.—*Naturalist, June,* 1876.

DOES THE AGE OF A TREE INFLUENCE THE TIME OF LEAFING?

M. Alph. de Candolle caused observations to be made in the botanical gardens of Paris and Pisa to settle this point. Unfortunately, however, the results were negative. M. De Candolle refers to one case in which the date of coming into leaf of a horse-chestnut tree has been carefully recorded for sixty-eight years, and another for fifty-seven years; both at Geneva. Of course any differences due to age would be small in comparison with those due to climate, yet they might be expected to be sensible in the long series of years if age really made any difference. But the figures do not bring to view any tendency to either earlier or later leafing with the advance of years.—*Archives des Sciences de la Bibl. Universelle.*

FLOATING SEEDS.

There is a considerable number of seeds with a specific gravity less than that of water, some as low as 0.75. Van Tieghem finds that this is due to different causes. More commonly the seed owes its lightness to its coats, either by a separation between the two in drying, or between the inner and the kernel, leaving an air-space, or by a loose cellular structure of the coat. Sometimes, as in castor-oil seeds, the integument is heavier than water, but the kernel is so much lighter as to float the seed. This comes from a separation of the two cotyledons during the natural desiccation, leaving a considerable cavity filled with air.—*American Journal of Science.*

RAPID GERMINATION.

Most gardeners have either heard or read of, if not seen, the singular rose of Jericho, *Anastatica hierochuntina.* The plant belongs to the Cruciferæ, and is a dwarf radiately

branched annual, inhabiting the sandy wastes of North Africa and Syria. We may repeat here that when the individual plant has fulfilled its mission—that is to say, produced flowers—and when the seed is in course of ripening, the leaves decay and fall off, and the branches curve inward, forming a ball of the entire plant. After this it soon becomes detached from the soil, and is blown hither and thither with the moving sands.

During this time the seed-vessels remain closed, but the first rain causes the branches to unfold and the seed-pods to open. Now it is obvious that the most favorable condition for the continued reproduction of an annual plant in the shifting sands of the desert must be quick germination and growth and a kind of locomotion. The strange prickly, almost or quite leafless shrubs and undershrubs characteristic of the desert flora retain their vitality for years, alternately buried beneath the sand and exposed to the influences of the sun and air; but an annual plant would probably soon become extinct under the same conditions. According to a writer in the *Gartenflora*, seeds of the *Anastatica hierochuntina*, sowed about five o'clock in the afternoon, had germinated by one o'clock the following day, and their rootlets had already pierced the soil. These seeds were taken from a plant purchased at the Vienna Exhibition, and twelve out of fifteen germinated in the time mentioned in a pot covered over with a saucer, and standing in an ordinary living-room. This, like the germination of the seeds of the mangroves on the trees, seems to be a special provision for the perpetuation of the species.—18 *A*, *September* 15, 1876, 11.

A NEW NOXIOUS WEED.

Of late years, among other noxious weeds at the South, one has appeared in great abundance, the hooked sides of which attach themselves very rapidly to the legs of cattle, and constitute a frightful nuisance, which, indeed, is spreading, and threatening to make its way over the whole United States before long. According to the Bulletin of the Torrey Botanical Club, in 1851 a woolen-factory near Augusta, Georgia, received a quantity of wool imported from Buenos Ayres. This contained a great number of small burs, which were separated by the picking-machine, and the "trash" thus re-

moved was thrown outside of the building. From these the species has been disseminated. It is known as the *Acanthospermum xanthoides.—Bull. Torrey Botan. Club, May,* 1876.

INVESTIGATIONS ON AMERICAN GOOSEBERRIES.

Professor Gray, in an article in the *American Naturalist* for May, in reference to the unsatisfactory condition of our knowledge in regard to the American wild gooseberry, invites botanists throughout the country to furnish information and specimens by which the difficulties may be cleared up. The species so far known to botanists are eleven in number, but the history of several of these is very indefinite.—*Bulletin Torrey Botan. Club, May,* 1876.

EXHIBITION BY THE AGRICULTURAL DEPARTMENT OF AMERICAN WOODS AT THE CENTENNIAL.

One of the most interesting features of the government exhibition at the Centennial is the collection of sections of forest trees displayed by the Agricultural Department, made under the direction of Dr. George Vasey, botanist of the department. This includes nearly 400 species and varieties of native North American trees, gathered directly for this occasion by twelve collectors in various parts of the Union. They embrace 50 species of sub-tropical trees of Southern Florida, including five that are new to our flora, and obtained by Dr. A. W. Chapman; 25 species from Texas, one of them believed to be new; 30 from Southern California and Arizona, embracing the tree yuccas and a recently known palm; 50 species from the Pacific slope of California; and 10 or 12 of the peculiar forms of Oregon. Among the 30 species from the Sierra Nevada Mountains are large sections of some of the noblest conifers of the world, such as the sugar-pine, the Douglas spruce, the silver-fir, and others.

The Rocky Mountains in Colorado and Utah furnish about 30 species; Illinois and the Western States, 50; Vermont, 20; and Virginia about 50, most of the latter being from the Mount Vernon estate, near Washington.

From the Southern States, exclusive of South Florida, there are about 90 species, one of them believed to be new. There are 30 species of oaks, 30 of pines, 16 of spruce, and 20 of other conifers. There is one extremely interesting group,

consisting of the tree palmettos, palms, and yuccas of the United States, embracing the Sabal palmetto from Florida, one palm from California, two yuccas from Florida, and three from Texas, Arizona, and California.

The sections referred to are not mere hand specimens, such as are usually found in collections, but in many cases they are two or three feet long, and of the full trunk whenever this is not too large for exhibition.

LIVING TREES AT THE CENTENNIAL.

Among the more interesting exhibitions at the Centennial is a collection of living woody plants exhibited by Mr. Thomas Meehan, of Germantown. These plants were all grown for a certain time in boxes, with special reference to their transplantation, and were inserted in the ground with balls of earth around them, so that they are now growing very vigorously. As this collection is for sale after the close of the Exhibition, it offers an excellent opportunity to any establishment in the United States that wishes to secure a collection of American plants of extraordinary completeness.—*D. Ill. Gewerbezeitung*, XXIII., 1876.

CHANGES OF COLORATION IN FLOWERS BY ARTIFICIAL MEANS.

The French *Journal of Horticulture*, in an article upon the changes of coloration which certain natural flowers undergo, remarks that if violet flowers are exposed to the smoke from a burning cigar they change color and assume a tint of green, which is decided in proportion to the brilliancy of their original color. This is due to the ammonia in the smoke. Starting out with this fact, Professor Gobba has made a series of experiments for the purpose of determining the changes which ammonia produces in the colors of different flowers. For this purpose he merely makes use of a dish in which is poured a small quantity of common aqua ammonia. Over this he places a funnel, in the tube of which are inserted the flowers to be experimented upon. In this way he has shown that blue, violet, and purple flowers change to a beautiful green; deep red carmine flowers to black, white to yellow, etc. These changes are most striking where the flowers have several different tints, in which the red lines are turned green, the white yellow, etc. An interesting example is that of the

fuchsias, with white and red flowers, which, in consequence of the ammonia vapor, become yellow, blue, and green. If, when these changes have taken place, the flowers are immersed in pure water, they preserve their new colors for several hours, after which they gradually resume their original tints. Another observation due to Mr. Gobba is that the flowers of the asters, which are naturally inodorous, acquire a very agreeable perfume under the influence of ammonia. The flowers of the violet asters also become red when they are moistened with a diluted solution of nitric acid. Again, these same flowers, if exposed in an open box to the vapor of hydrochloric acid, become after some hours of a beautiful carmine red, which they preserve after being dried in the dark, if kept in a dry, dark place.—1 *B*, *April* 4, 1876, 422.

PRESERVATION OF CUT FLOWERS AND BOUQUETS.

A German journal recommends for the preservation almost indefinitely of cut flowers, singly or in bouquets, to dip them in a solution of pure albumen, and, after allowing them to become perfectly dry, to repeat the operation several times, each time with fresh albumen.—10 *C*, *May* 1, 1876, 79.

VARIETIES OF INDIA RUBBER.

A recent writer enumerates the following varieties of India rubber as known in commerce: 1, Ceara rubber; 2, Para rubber; 3, Quisembo balls from Sierra Leone; 4, African knots in small irregular quadrangular pieces about an inch square; 5, Mozambique rubber; 6, African niggers in small round lumps about two inches in diameter; 7, Madagascar rubber; 8, Carthagena rubber; 9, Borneo rubber; 10, Rangoon rubber; 11, African rubber; and, 12, Guayaquil rubber from Ecuador.—*D. Ill. Gewerbezeitung*, XXIII., 1876.

A NEW DRYING OIL.

The *Elæococca Vernicia*, or *Tong-Yeou*, a tree growing in China and Cochin-China, produces abundantly a fruit consisting of a capsule filled with grains rich in oil. This oil is easily extracted by pressure, has a density of 0.9362, and possesses a variety of curious properties. According to Cloez, who has lately submitted it to thorough investigation, it dries more rapidly than any other known oil, a coating of it ap-

plied to glass or clean metallic surfaces becoming dry in a very few hours. An attempt will probably be made to acclimatize the plant in Algeria, with a view toward rendering it useful in the arts and introducing it into commerce. One of the most remarkable facts connected with the oil is its power of solidifying under the action of light and out of contact with the air. Heated in the air it also becomes solid, this change being, however, a chemical one due to oxidation. —6 *B, September* 13, 1875.

THE HEATH IN AMERICA.

It has been a generally received impression that North America, in distinction from Europe, is without any species of heath or heather, a few specimens of the *Calluna vulgaris* detected in Newfoundland having been considered as introduced rather than as indigenous. Great, therefore, was the gratification of sentimentalists at the discovery of this plant in Tewksbury, Massachusetts. Afterward the same plant was discovered in Nova Scotia and Cape Breton, and subsequently on Cape Elizabeth, near Portland. Dr. Gray now announces in the *American Naturalist* the discovery of a second station in Massachusetts, to the west of Andover, about five miles north of the Tewksbury station. A signal feature in this connection is the vicinity of a glacial moraine which traverses the district.—5 *D, August*, 1876, 490.

EFFECT OF SOLUTIONS ON A GROWING VINE.

Baudrimont has been continuing his experiments upon the influence upon the branches of a growing vine of immersion in water containing various substances in solution, and has obtained some rather remarkable results by various poisonous agencies, some appearing actually to increase the vigor of growth of the vine and prolong its existence, as in the case of chloride of potassium; while others cause the plant to wither, as in creosote and carbolic acid. Bromide and iodide of potassium seem to act in the same manner as chloride of potassium. Chloral hydrate exercises a very poisonous influence, destroying the branch vine in three days, the effect differing from that of carbolic acid. One of the most curious phenomena is that which is exhibited in the fall of the leaves. In some instances the petiole becomes detached at the point

where it is inserted in the branch. This takes place in case of most substances, such as bichloride of mercury, and chloride, bromide, and iodide of potassium. In other cases it is the limb which separates from the extremity of the petiole. This occurs with ordinary water, and the nitrates of ammonia, potash, and soda. In one single instance both forms of separation have been observed, under the influence of the same substance. Sometimes, again, the branch dies while the leaves continue to adhere to it. This is the case after the use of hydrocyanic acid and the essence of turpentine. Chloride of potassium acts as an invigorating and preserving agent, quite exceptional in its character. A current of ammonia allows the branch to preserve its freshness for eight days, after which it withers.—1 *B*, *December* 20, 1874, 189.

PLANTS OF NEW GUINEA.

The *Gardener's Chronicle* states that letters received from Ternate mention the fact that Dr. Beccari has discovered on Mount Arfok, in New Guinea, quite a number of new species of plants of well-known genera, belonging to very different portions of the globe. Among these are *Araucaria*, species of *Vaccinium*, *Rhododendron*, *Podocarpus*, etc.

SECRETION OF DROSERA.

The alleged insectivorous habits of certain plants, such as *Drosera* and *Dionæa*, have attracted attention to the question of the composition of the viscid substance secreted by the glands on the leaves of species belonging to the former of these genera. The properties of this substance are evidently closely analogous to those of the pepsin which is the ferment secreted in the human stomach, and it is said even to give off the odor of pepsin on treating with sulphuric acid; but the quantity in which it has hitherto been obtained is too small to admit of accurate analysis. Professor Frankland, of London, obtained results which convinced him that the substance was an acid or mixture of acids belonging to the fatty or acetic series; and he thinks he obtained certain evidence of the presence of propionic and probably also of acetic and butyric acids. Mr. Lawson Tait, of Birmingham (England), on the other hand, believes he has proved the main ingredient to be lactic acid, while Professor Will,

of Erlangen, finds formic acid to be certainly present (which Frankland failed to detect), as well as indications of propionic and butyric acids. Mr. A. W. Bennett, of London, has detected glands in the leaves of Drosera and Pinguicula, which seem to have hitherto escaped attention, and which he believes to be intimately connected with the processes of absorption and digestion.

FLORA OF GUADALUPE ISLAND, LOWER CALIFORNIA.

Mr. Sereno Watson publishes in the Proceedings of the American Academy of Arts and Sciences a report on the Guadalupe Islands of Lower California, lately explored very thoroughly by Dr. Edward Palmer. In this he shows that the flora is to be considered as part of that of California, as distinguished from that of Mexico, but that it has been derived to a considerable degree through human agency. Those of the most recent introduction might be expected to be Californian; the older might be from the nearer peninsula, or from other localities. It might be inferred, also, that it has not been derived from California by any existing process of conveyance and selection, but that it is rather indigenous to its present locality. Moreover, while it would indicate a connection at some period between the island and the mainland to the north, yet the number and character of the peculiar species favor the opinion that they are the remnant of a flora similar to that of California, which once extended in this direction considerably to the southward of what is now the limit of that flora upon the mainland. Finally, the presence of so many South American types suggests the conjecture that this and the similar element which characterizes the flora of California may be due to some other connection between these distant regions than any which now exists, and even that all the peculiarities of the western floras of both continents had a common origin in an ancient flora which prevailed over a wide now submerged area, and of whose character they are the partial exponents.

The study of the birds collected by Dr. Palmer suggested somewhat the same conclusions. These are in every respect closely allied to those of California, but sufficiently different to entitle them to be considered as well-marked geographical

races, no single species of the land birds found being precisely identical with one of any other part of the continent. It should be remarked that the island is about 100 miles from the coast of Lower California, and 230 miles west of south from the town of San Diego. It is twenty-six miles long and about ten miles in width, and has a mountain ridge with one elevation of 3900 feet above the level of the sea.

VARIATIONS IN PLANTS WITH THE ALTITUDE AT WHICH THEY GROW.

According to Ebermeyer, the size of leaves of a given species of tree is considerably affected by its height above the sea-level; with equal strength of soil the leaves decreasing with the height. In the case of the red beech of Germany, the surface of the leaves on low lands is three to four times greater than on the mountains. As a general rule the quantity of humus in mountain forests is greater than in those lower down, owing to the slower decay of the leaves consequent upon a lower temperature. It is given as a remarkable fact by Ebermeyer that the entire amount of ashes of the strewn materials decreases with the height, and that the proportion of phosphoric acid, especially in the ashes, is much less in high positions than on lower ground. Hence it follows that the value of the dead leaves as manure decreases in general with the height, and that, consequently, the carrying away of material from the low lands for other purposes is much more disadvantageous than from the mountains as far as plant nutrition is concerned.—18 *A*, *February* 26, 1875, 601.

OCCURRENCE OF THE PALM-TREE, SCHEELIA REGIA.

Bruchmüller narrates that in his passage up the Magdalena River, New Granada, he noticed a tall palm—*Scheelia regia*—so entirely surrounded by a growth of a species of fig-tree—*Ficus dendroidea*—that the top only was visible. This species of palm, under the names of Palma roal and Palma dé vino, occurs frequently lower down the river, and the natives obtain from it a covering for their huts, and prepare a kind of wine similar to champagne from the sap and a most excellent salad from the heart, while other portions afford strong fibres.—1 *C*, II., 1875, 14.

THE TRUE JUTE PLANT.

There appears to be considerable confusion as to the plant from which the substance so extensively used in the arts under the name of jute is really derived. On investigation, however, it appears that the crude jute comes from two species of *Corchorus*, namely, *C. capularis* and *C. olitorius*, grown principally in Bengal. Plants popularly known as jute, however, growing in the Madras Presidency, are the *Hibiscus cannabinus* and *Crotalaria juncea;* and their fibre is not the true jute, though hitherto considered such.—12 *A, February* 18, 1876, 314.

DEVELOPMENT OF FUNGI.

The following is condensed from an exceedingly interesting and well-illustrated paper, by Worthington G. Smith, F.L.S., on reproduction in the mushroom tribe. The author finds when a single specimen of *Coprinus radiatus* has been placed on a slide with a drop of water, under a covering glass, and this again under a propagating glass, that as the millions of fungous cells quickly disappear, so millions of infusoria just as quickly come into being; and he says, "It seems almost reasonable to believe that the fungous cells themselves become suddenly transformed, and reappear as simple infusoria." A dozen semi-decayed specimens of *C. radiatus*, swarming with minute infusoria, were boiled in a test-tube for five minutes, and then hermetically sealed at the highest point of ebullition. At the end of a month the tube was opened, and a drop of its liquid contents at once placed under the cover-glass of the microscope for examination. Spores, cells, monads, bacteria, and vibriones were all there, but the latter motionless and apparently dead. In fifteen minutes, however, they showed signs of life, and began to slightly move about; in thirty minutes the movements were decided in nearly every specimen seen, while in sixty minutes the infusoria darted about with almost the same energy as they did before they were boiled. As there are about 22,500,000 cells in one of these minute plants, requiring fourteen days for their production, it follows that the cells go on multiplying all the fortnight at the rate of 1114 to the minute. In about five hours 3,000,000 spores are produced.

They as a consequence appear upon the basidia or spore-bearing spicules at the rate of 100,000 every minute!—*Gardener's Chronicle, October* 16–23, 1875.

GLANDS OF CARNIVOROUS PLANTS.

Those plants which possess the peculiar power of absorbing and digesting nitrogenous substances presented to their leaves are principally insectivorous plants, belonging to the genera *Drosera*, *Pinguicula*, *Dionæa*, and *Utricularia*. In all these, minute glands exist imbedded in the surface of the leaf, reddish-purple in *Dionæa*, and giving a red tinge to the leaf. They are smaller than stomates.—*Monthly Microscopical Journal, January*, 1876.

THE POTATO DISEASE.

For more than thirty years our potato crops have been systematically destroyed by two virulent fungi, viz., *Peronospora infestans* and *Fusisporium Solani:* these two parasites almost invariably work in company with each other; they suddenly appear for a few weeks, destroy our crops, and vanish for ten or twelve months, then reappear and repeat the work of destruction. Mr. Worthington G. Smith has shown how these fungi hide and sleep through eleven months of the year. He has kept the resting spores of both parasites alive, artificially, in decayed potato leaves, under water, in moist air, and in expressed juice of horse-dung; it is fair to conclude that the resting spores hibernate naturally in the same manner. The seat of danger from both parasites is clearly in dung-heaps and decaying potato plants. In July last Mr. Smith obtained the oospores, or resting spores, by keeping potato leaves and tubers constantly moist, and preserved the material in which the resting spores were present in sealed bottles, containing more or less pure water, or expressed juice of horse-dung diluted with water, quite in the dark as to what the results might be. After waiting with considerable anxiety, and dividing the material to insure against loss, and keeping it constantly moist and in the dark, and under examination every day for over three months, during the latter stages of growth he detected the following changes: Many of the resting spores increased in size to twice their original dimensions during the first nine months, chang-

ing from almost smooth and transparent bladders, to brown, somewhat rough, and warted or echinulate spheres. Similar ones had been previously observed in the natural growth the previous summer, though no one then could account for their origin. At the end of nine months germination began, the resting spores became dense and dark, the oospore occupying the whole of the oogonium, instead of floating freely inside as in the immature spore; the contents of many of them were broken up into zoospores with two tails, which live in this form somewhere between twelve hours and a week, when they come to a rest and the tails disappear. Many of the zoospores perished, but others threw out threads of mycelium, which were destined at length to bear the conidiphores of the potato fungus. The oospores which did not produce zoospores protruded a thick, jointed thread, agreeing exactly with average *Peronospora infestans* threads. As any method of destroying the resting spores of these pests depends upon a knowledge of their life-history, this contribution of Mr. Smith will be welcomed as a move in the right direction. The paper itself, with four plates, was first published in the *Gardener's Chronicle*, 1876, p. 39–42, and since in *Grevillea* and the *Monthly Microscopical Journal*, *Sept.*, 1876.

DISEASES OF OLIVE AND ORANGE TREES.

Professor W. G. Farlow, of Harvard, has recently been investigating the disease of olive and orange trees, caused by fungous growths, and has arrived at the following results: The disease first attracts the eye by the presence of a black fungus, which however is not the cause of it, but rather the attack of some insect, which itself deposits a gummy substance on the leaves and bark, or so wounds the tree as to cause some sticky exudation, on which the fungus especially thrives. In seeking a remedy, we are to look farther back than the fungus itself—to the insect or whatever it may be which has made the luxurious growth of the fungus possible. It is the same on both olives and oranges, and has been described by Tulasne as *Fumago salicina*, found on willows, oaks, birches, hawthorn, quince, and pear, the stylospore-bearing portion being the *Capnodium citri* of Berkeley and Desmazières, and the pycnidal form the *Antennaria elæophila* of Montagne. Professor Farlow suggests as a remedy alkaline soaps, strong as the trees will bear.

I. AGRICULTURE AND RURAL ECONOMY.

USES OF PRODUCTS OF THE STONE-PINE TREE.

The stone-pine of Europe is applied to a great many uses, some of which may suggest a similar employment of the well-known piñon, or stone-pine of Colorado, New Mexico, and the central portions of the United States. The seeds are considered preferable to almonds, in consequence of their more delicate and aromatic taste, and they are said to be chiefly consumed on steamboats during long voyages, and for dessert at the principal hotels. In portions of Europe the investing pellicles are used for filling mattresses for hospitals, and they are said to make very wholesome beds. The unopened pine-cones are believed to be efficacious in preserving cloth garments and furs from moths.—17 *A*, *July*, 1875, 105.

COVERING THE SLOPES OF THE ALPS WITH FORESTS.

Among the objects exhibited at the recent Geographical Exposition in Paris is a series of maps illustrating the progress in reclothing the slopes in the Department of the Basses-Alps with a growth of wood, this relating especially to the basin of the torrent of Bourget, commenced in 1869. Considerable time was occupied by the preliminary surveys, but the process of replanting has already been begun with such effect as to insure the protection of the hamlet of Bourget, which had been threatened with destruction by being washed away. The influence exerted upon population and human existence by deforesting or the destruction of the woods is shown by the fact that in 1846 the population of one Department in the Alps of France amounted to 150,000 persons, while in 1872 only 137,000 could be enumerated, 13,000 having been forced to remove elsewhere in consequence of the decreasing quantity of fertile land.—1 *B*, 348.

THE PROPER TIME FOR CUTTING TREES.

An extensive inquiry has been made in Prussia into the effect upon the durability of woods of the season at which the

trees are cut down. In general, the wood felled when the sap is not running has a decided pre-eminence as to its durability, strength, and density. The heat given out in burning wood felled in December and January is also, according to these experiments, greater than for woods cut in February and March.—7 *C*, XI., 123.

THE DESTRUCTION OF FORESTS.

The rapid and improvident destruction of our forests, and the prevailing indifference displayed on the subject of their conservation and cultivation, has become an almost stereotyped theme of warning and regret. It is demonstrable that the immediate consequences of this improvidence are an inconstancy and diminution of the rainfall, and a general deterioration of climate, to say nothing of a host of more remote and complex evils that follow inevitably in its train in course of time. These consequences have been abundantly realized in the desolation that has overwhelmed once fertile districts of Europe, and has stimulated the enactment and enforcement of wise laws which our lawgivers would do well to imitate. Councilor Wex, at the recent yearly meeting of the Geographical Society of Vienna, gave an able review of this most important subject as it affected the water supply of Central Europe. From the facts adduced in his paper, Herr Wex demonstrated a fall in the level, since fifty years, of 17 inches in the Elbe, 24.8 inches in the Rhine, 17 inches in the Oder, 26 inches in the Vistula, and in the Danube at Orsova as much as 55 inches. Accompanying this fall in level, which means so much of a decrease in the volume of these rivers, there was also shown to be a constantly increasing diminution of the discharge from springs. It would be instructive to have trustworthy data upon this subject from that portion of the United States east of the Rocky Mountains where the destruction of timber land has been for years going on on a scale of unparalleled magnitude.

CULTIVATION OF THE BAMBOO IN FRANCE.

A peculiar variety of bamboo has been sent to the Acclimatization Society of Paris, which it is believed will readily adapt itself to the climate of France, and may prove of very great value. It is said, indeed, that the French growth has

already become an article of export to England, being very hardy, and able to sustain itself in both hot and cold countries. It grows rapidly, attains a height of thirty yards, and multiplies very fast.—17 *A*, *July* 1, 1875, 107.

CAOUTCHOUC FROM MILKWEED.

A report has gone the rounds of the technical press that the manufacture of rubber from the milkweed (*Asclepias*) has been undertaken by a company in Canada with a large capital. The milky juice of this family of plants is said to yield four per cent. of caoutchouc.

NEW LARGE JAPANESE RADISH.

A new variety of radish, the seeds of which were forwarded from Japan by Dr. Genou, has been introduced into the French market under the name of *Raphanus acantiformis*, and is pronounced an acquisition of value. In color it is milk-white, with a tinge of yellow, and it is firm, transparent, and juicy, and of delicate flavor, while the skin is thin and peels off easily. In Japan, where it is cultivated under the name of *Daicon*, it frequently attains a length of thirty-five inches, with a corresponding thickness; and it is used in a great variety of forms as food, and is frequently fed to cattle on account of its great yield. At Lyons it has been grown eighteen inches long and twelve inches thick. It is sowed in July and August, and requires for its full development a loose, well-manured soil, and frequent watering in September. —7 *C*, *March*, 1875, 35.

VALUE OF THE COMMON BROOM PLANT AS A FIBRE.

The common broom of Europe (*Spartium junceum*) is announced as furnishing a fibre equal and in some respects superior to that of hemp and flax. In view of the great extent to which this plant occurs wild in Southern Europe, and the ease with which it is cultivated, such application, not indeed new, but only more recently revived, promises important results. Its fibre can be very minutely divided, and, as it retains heat, it can supply the place of wool. It receives the most delicate dyes as well as an animal fibre, and successfully resists the action of acids and salt water without undergoing any change or losing its tenacity. Its strength

is one third greater than that of hemp, while it is thirteen per cent. lighter. It can be furnished, delivered at the factories, for about £2 per ton. The fibre may be obtained by soaking the stems for a few days in warm water, or else by means of a chemical solution of little cost.—17 *A*, *March* 1, 1875, 41.

AUTUMN PLANTING OF POTATOES.

Experiments have been conducted in Paris with reference to a method of autumn planting of potatoes, by which new potatoes may be dug in January. The sets are planted in August on a thin layer of salt, which appears to be the special secret in the process, and the potatoes are earthed in September, the ground being cleared of weeds in October. The result is a crop of seven or eight fair-sized tubers to each root in January.—18 *A*, *February* 19, 1875, 575.

IMPORTANCE OF PEAT BEDS.

In some remarks on the climatology of New Hampshire, Professor Huntington states that the preservation of the vegetation on our mountains is of great importance, not only in modifying the distribution of rain, but also in modifying the extreme of cold in winter. Our mountains, especially the higher summits, are covered to a considerable depth, except where it has been destroyed by fires, by peat, formed chiefly from moss and lichens. Now it has been found by experiment that peat moss can absorb more than twice its own weight of water; dry clay, nearly its own weight; dry earth or garden mould, more than half its own weight, and dry sand a little more than a third of its own weight. With equal times of drying, under the same circumstances, therefore, peat moss loses two thirds of all the water it contained; clay and earth more than three fourths, and sand more than nine tenths. Thus, in a dry season, beds of peat must form an invaluable reservoir of water for the supply of springs and streams. Wherever it or vegetable mould abounds, the soil retains its moisture, being only gradually evaporated; a high relative humidity is maintained, and springs gush forth from the slopes of the mountains, and a slight change in the temperature causes rain to fail in gentle showers. It is noted that on the mountains of New Hampshire fires in gen-

eral spread only over their eastern slopes.—*Climatology of New Hampshire*, 1874.

PREVENTION OF THE FREEZING OF FRUIT IN THE BUD.

The freezing of fruit in the bud, frequently occasioned by a few warm days succeeded by late frosts, it is said, may be prevented by spreading a thick layer of frozen manure, or of ice or snow, around the trees in February or March, while the ground is firmly frozen. The buds will thus be kept back, since the ground will thaw more slowly, and the roots convey no nutriment to the tree. When frosts are no longer to be feared the covering should be removed.—10 *C, August* 1, 1875, 123.

SMOKE AS A PROTECTION AGAINST FROST.

The production of artificial clouds of smoke is a common appliance against frost in France and Germany. M. Vinard recommended a plan which is perfectly successful, and which consists in carefully mixing gas tar with sawdust and old straw, and piling up this mixture in large heaps in the vineyards. The mixture remains inflammable more than a fortnight, in spite of rain and weather. When required for use smaller heaps are made from the large ones, about two feet in diameter, and distributed in and around the vineyard. If there is little wind these heaps burn freely for about three and a half hours, and produce a very dense smoke. The artificial cloud which thus enwraps the vines considerably decreases the radiation from the ground, and therefore prevents frost, which is greatest toward morning during calm spring nights.—12 *A*, XI., 396.

THE EVAPORATION FROM THE SKINS OF FRUIT.

By comparing the evaporation from apples with and without their outer skins, Just has arrived at the following conclusions: 1. The resistance which the skin offers to evaporation is quite energetic at low temperatures, but diminishes sensibly above the temperature of 46°, until it becomes barely sensible at 97°. 2. In the case of pared apples, a covering is formed from the dried exterior cells, which opposes rapid evaporation. 3. This exterior covering is formed gradually, so that its retarding influence is scarcely felt for the first

twenty-four hours, during which time evaporation continues very rapid. 4. A similar covering of dried cells forms in the case of unpared apples only after the exterior layer of cells has dried up very much. The application of these results to preparing dried apples shows that for their rapid production in the best condition they must be dried at as low a temperature as possible after having been pared.—19 C, VIII, [illegible]

INFLUENCE OF THE SUN-SPOT PERIOD ON THE PRICE OF GRAIN.

Professor Jevons recently read an interesting paper on the influence of the sun-spot period upon the price of grain. In making a comparison between two phenomena apparently so distinct from each other Professor Jevons has made use of the [illegible] of prices of commodities in England between [illegible] and 1400, as published in Professor Rodgers' "History of Agriculture and Prices in England." He finds [illegible] each kind of produce rise during the first [illegible] sun-spot period, and then fall. The [illegible] occur in the tenth, eleventh, first, second, [illegible] years.

[illegible] OF CERTAIN PLANTS AMONG THE ABORIGINES.

The Bulletin of the Torrey Botanical Club contains a [illegible] from Dr. J. H. Trumbull in reference to the [illegible] existence of certain vegetables in America at [illegible] the first visit of the whites. He quotes from [illegible] Vaca, who found in 1528, near Tampa Bay, maize, [illegible] pumpkins. Cartier, in his first visit to Canada in [illegible] beans and melons. Hudson, in 1609, when on the [illegible] was supplied with Indian corn, pumpkins, and to[illegible] Champlain, on his voyage in 1604, found beans, mel[illegible] tobacco on the Connecticut River. Purslane is also [illegible] substance known to the Indians in the earliest

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[illegible]NECTICUT AGRICULTURAL EXPERIMENT STATION.

[illegible]s not long since introduced into the Connecticut [illegible]re providing for the establishment of an agricultural [illegible]nt station on the plan of those which have proved [illegible]ble in Germany and elsewhere in Europe, and pro-

viding an annual appropriation for the purpose. This, however, failed to become a law. Mr. Orange Judd, the well-known editor and proprietor of the *American Agriculturist*, then with characteristic liberality offered on his own part $1000, and, on that of the trustees of the Wesleyan University, the free use of laboratories and appliances for the purpose in the Hall of Natural Sciences (given by himself to that institution), provided the Legislature would appropriate a sum of money for the establishment of a station. In answer to this the Legislature passed almost unanimously a resolution "to promote agriculture." The preamble to this reads as follows: "Whereas, the trustees of the university at Middletown tender the free use of ample laboratories, and other facilities for establishing and carrying on an experiment station for the general benefit and improvement of agriculture and kindred interests of the state of Connecticut."

The resolution provides "that the sum of seven hundred dollars per quarter for two years is hereby appropriated to the university located at Middletown, Middlesex County, to be used in employing competent scientific men to carry on the appropriate work of an agricultural experiment station," and directs the comptroller to pay the sum specified to the treasurer of the university, provided "the said treasurer shall satisfy the comptroller that such money is expended in the employment of scientific men for making the investigations and experiments contemplated in this resolution; and that the said university shall superintend such experiments, and shall provide ample laboratories and buildings therefor free of charge."

The station is now fully organized. Professor W. O. Atwater, of the university, Dr. W. C. Tilden, and two assistants are engaged in the work. An advisory committee of prominent farmers of the state has been appointed to give counsel in the management of the station, and to facilitate its connection with the public. Hearty sympathy and encouragement are manifested on all sides, and it is hoped that the first two years of its labor will prove so successful as in the future to insure from the state support commensurate with the importance of its object.

PROPOSED UTILIZATION OF FISH-BONES.

German manufacturers are continually engaged in purchasing fish-bones, gathered along the Norwegian shores near extensive fish-curing establishments. These are pulverized and converted into fertilizers. It is suggested that arrangements be made for utilizing the bones from the establishments in Newfoundland, such products of American fisheries, being estimated at 120,000,000 pounds per year. — 23 *A*, XXII., 263.

WHAT POTASH SALTS TO BUY.

Professor Goessmann concludes that our dealers act in the best interest of their consumers by importing none but 80 per cent. containing muriate of potash, and 40 to 50 per cent. containing sulphate of potash, the former being equivalent to 50 per cent. of potassium oxide, the latter to 25 per cent. These compounds are the cheapest of their kind, and answer the requirements of both general and special farming. Our farmers do best as a general rule to ask for the higher grades of these fertilizers, and to use the lower grades, if cheap, only for forage crops.—*Rept. Sec. Mass. Board of Agric.*, 1874–5, 362.

WOOD-ASHES AS A POTASH FERTILIZER.

From a very elaborate and thorough investigation of the composition of wood-ashes from household fires, by Professor Storer, it appears that these contain, unleached and dry, about 8½ per cent. of potash, somewhat more than the lowest grades of German potash salts. Either leached or unleached, the dry ashes contain about two per cent. of phosphoric acid, of which none occurs in the German salts. In Storer's field experiments, wood-ashes (unleached) applied in large quantities brought larger yields of barley, beans, and rutabagas than farm-yard manure, city stable manure, or any single potash salt, as sulphate, carbonate, or even nitrate. In commenting upon these results, Storer says: "Wood-ashes are more serviceable than any single potash salt, not only because they contain some phosphoric acid, lime, magnesia, and the less valuable elements of plant-food, but because, considering them merely as a potassic manure, they contain a mixture of potash salts. It may be regarded as well-nigh certain

that a given amount of potash, applied in the form of appropriate mixtures of sulphate, carbonate, silicate, and chloride of potassium, will, generally speaking, do more good than when applied in the form of either one of these compounds. But in wood-ashes we find a mixture of these salts ready at hand; not the best mixture, perhaps, but one already formed, and in this country at least very easily obtained."—*Bulletin Bussey Inst.*, I, 127.

VALUES OF POTASH FERTILIZERS.

The potassium in the German potash salts occurs either as potassium sulphate, "sulphate of potash," or as potassium chloride, "muriate of potash." It generally comes at a lower price per pound as chloride than as sulphate. But, as Professor Goessmann very justly remarks, there are other things besides first cost to be considered in buying these manures. Long experience in Europe has shown that the form in which the potassium is present, as well as the amount and nature of the other compounds that occur in the German salts, controls to a great extent their action upon various crops and soils. The sulphate of potash is unanimously approved as the safest potash compound—without regard to kind of crop—and as far as the quality of some of the industrial products are concerned. It increases the percentage of starch in potatoes, and of sugar in sugar-beets. It counteracts best, in common with nitrate of potassa, the tendency of tobacco to char and to smell offensively, thereby rendering it better adapted to smoking, and increasing its commercial value. Upon wet lands alone the sulphate is considered as unprofitable, and the chloride of potassium the safer article. The chloride of potassium, on the other hand, has not received such general commendation. Its use as a fertilizer for potatoes and tobacco has been decidedly discouraged, for it acts on these crops more in the direction of quantity than quality. It is, however, highly recommended for meadows, for pasture lands, and for all kinds of forage and grain crops, particularly when applied in connection with phosphates. The relative agricultural value of both series of compounds, chlorides and sulphates, is also frequently and in an unusual degree modified by the presence of certain other saline compounds, which are found associated with them in the mines.

Most prominent among these are sodium chloride (common salt), magnesium chloride, and magnesium sulphate. The presence—more than mere traces—of magnesium chloride is decidedly objectionable, for its action on plant growth in general is known to be destructive. It favors, also, the transformation of lime in calcium chloride, and thus assists in sending this valuable constituent down into the drainage water. A large admixture of common salt—(some of these fertilizers contain from 40 to 45 per cent.)—renders them unprofitable for the cultivation of the more important industrial crops (for instance, tobacco).—*Rept. Sec. Mass. Board of Agric.*, 1874–5, 358.

GERMAN POTASH SALTS.

The need of potash as a fertilizer has been impressing itself more and more, of late, upon farmers throughout the country. The discovery of the immense deposits of potash salts in the mines of Stassfurt, in Germany, and the beneficial results of their use as manure in Europe, have led to the importation of considerable quantities to the United States. Unfortunately, much of this imported material has been of the lower grades, which contain but little actual potash compound, the largest portion consisting of salts of soda and magnesia, and other materials of small agricultural value, among the rest, chloride of magnesium, which is actually harmful to vegetation. The amount of "actual potash," *i. e.*, potassium, reckoned as potassium oxide, in the German salts varies from seven per cent. in the lowest, to over fifty per cent. in the highest grades. Eight samples analyzed by Professor Goessmann contained respectively 7.97, 7.56, 8.72, 8.37, 9.18, 10.14, 16.21, and 50.30 per cent. of potassium oxide. The three lowest results were from fertilizers represented to contain 32.34 and 41 per cent. respectively. The two highest were nearly or quite equal to the dealers' guarantee. Not only were the poorer articles deficient in potash, but they contained considerable chloride of magnesium; and, further, the larger proportion of their potassium proved, as Professor Goessmann states, to be present in the form of chloride of potassium, and they belong consequently, without exception, to those low grades of German potash salts which are commonly called "Dung salts." . . . To buy these low grades of

potash salts is, even in Germany, not considered economical on the part of farmers, for they have learned that whenever the cost of transportation of one hundred pounds of potassium oxide exceeds about sixty cents, the higher grades become the cheaper article. To pay an additional freight across the Atlantic on 1800 pounds of material, which we have in abundance and cheaper at home, for the purpose of securing 160 to 200 pounds of potassium oxide, can not be the best course to obtain a suitable supply.—*Rep. Sec. Mass. Board of Agric.*, 1875–6, 354.

THE COMPOSITION OF AMERICAN WHEAT PRODUCTS.

Important additions to our knowledge of the chemical composition and nutritive value of some of our common feeding materials for cattle have been made by Professor Storer, of the Bussey Institution of Harvard University, in analyses of Western shorts (bran), middlings, and shipstuff. Until lately very few trustworthy analyses of American vegetable products had been made, and it has been necessary to depend upon tables of European analyses for estimates of their composition. The names given to the by-products from the manufacture of wheat into flour vary in different parts of the country. "Shorts" and "bran" are generally synonymous. "Middlings" is usually applied to a meal-like product, ranking in composition and fineness midway between shorts and flour. The terms "millstuff" in Boston, "millfeed" in Chicago, and "shipstuff" in the South, seem all to apply to a mixture of shorts and middlings, which include every thing not flour that is separated from wheat. On comparing his own results with the most trustworthy European analyses, Professor Storer finds that these products in this country are somewhat dryer than the corresponding European ones. Three samples of Western shorts, for instance, average 11.65 per cent. of water, while the average of European bran was 13.24 per cent. This difference Professor Storer is inclined to attribute to the greater dryness of the atmosphere in this country. There was a similar difference in the amount of albuminoids, the average in American shorts being 11.75 per cent. and in European bran 13.44 per cent. For this two reasons are suggested. First, the flour, which, as is familiarly known, contains less albuminoid (nitrogen) than bran, is less

completely separated from the bran here than in Europe. Second, Western shorts often lose weight in storage and transportation. In standing in heaps they not unfrequently "heat," and "shrink" to the extent of twenty per cent. of the original weight. In the process of fermentation, to which this is largely due, the albuminoids would be found to suffer decomposition and loss.

FURNACE FOR BURNING HAY, STRAW, ETC.

The necessity for some practical device whereby vegetable refuse of various kinds, such as straw, hay, dry leaves, seaweed, etc., may be conveniently utilized as fuel in those regions where coal is expensive and timber scarce, has long been recognized, and several attempts to solve the problem have been made. The following is a description of one of the most promising inventions for this purpose. It consists of a box of stove sheet-iron, in which is a heavy press follower, which by a simple mechanism can be moved up and down, and thus arranged to maintain a steady pressure upon the hay, or similar material, placed in the fire-chamber. The supply of fuel is regulated by a feeder, and a suitable attachment adjusts the grate relatively to the follower, according to the quantity of material placed between them. The inventor claims that by this arrangement, the fuel being under pressure, combustion can go on only around the sides to which the heat and air have access; the consumption of fuel is therefore very slow, and can readily be graduated by the draft supplied. One hundred pounds of hay or straw, it is claimed, will be sufficient to supply the stove during the coldest weather, and six or seven tons will suffice for an entire winter.—6 *D*, XXXIII., 119.

NUTRITIVE VALUE OF SHORTS, MIDDLINGS, AND SHIPSTUFF.

Analyses by Professor Storer show that these American wheat products are very valuable as food for domestic animals. In the latest tables of Wolff, of the Agricultural Experiment Station, at Hohenheim, in Germany, European bran is reckoned as worth twelve per cent. less than rye, and thirty-five per cent. more than average hay. The estimates are based upon the amounts of actually digestible food ingredients contained in them, certain values per pound being as-

sumed for albuminoids, carbo-hydrates, and fats. Taking rye as the standard, and calculating what number of pounds would contain one dollar's worth of these ingredients, the same number of pounds of European bran would be valued at 87 cents, St. Louis "shipstuff" at 88 cents, and corn meal at 94 cents. The middlings and shipstuff contain less of albuminoids and fats, and more of carbo-hydrates than the shorts or bran, but must be a trifle more digestible. The estimated value would not differ greatly from that of the bran or shorts. "It is worth noting," Professor Storer remarks, "that the ash of bran (or shorts) contains an unusually large percentage of phosphates (over fifty per cent. of this ash is phosphoric acid, calculated as if it were free and uncombined), and that every ton of shorts or middlings contains from thirty to fifty pounds of ash. All the varieties of bran are consequently well fitted to supply the phosphates needed by milch cows and growing animals; and the manure from animals fed with bran will, of course, be especially rich in phosphates.—*Bulletin Bussey Institution*, I, 39–185.

SALT-MARSH AND BOG HAY: THE FEEDING VALUE.

Professor Storer has examined a number of coarse hays, including particularly several specimens of bog and salt-marsh hay, such as are commonly used for fodder and manure in New England. As regards chemical composition, these stand midway between ordinary upland hay and straw of the cereals. That is to say, straw contains in general less of albuminoids and fats, but more crude fibre (cellulose) than good hay. These coarse hays have less of albuminoids and fats than the hay and more than the straw, so likewise they contain more crude fibre than the hay and less than the straw. The practical bearing of these facts is very important. One great defect of our ordinary forage materials is a lack of albuminoids (nitrogenous material). Late investigations at the European experiment stations have shown that the functions of nitrogen in nutrition are more important than was formerly supposed, and that only the best qualities of hay contain as large a proportion of these as is required by milch cows, and for working and fatting animals for the highest production. The poorer qualities of hay, however, furnish a good deal of digestible and nutritious material, but are

deficient in albuminoids. To use these coarse hays economically, other materials rich in digestible albuminoids should be added. Such are oil-cakes, beans, pease, bran, etc. And Professor Storer very justly remarks that "there are many places where it would be not merely good practice, but really excellent farming, to feed out upon the farm the hay from coarse natural herbage, with the addition of small quantities of the more concentrated forms of food, and send off from the farm, in so far as might be practicable, the more costly upland hay, to be marketed like any other merchantable product."

ARTIFICIAL DRYING OF HAY AND GRAIN.

Considerable interest has been excited in agricultural circles in England in regard to the apparatus invented by Mr. William Alfred Gibbs for drying hay and grain artificially during damp weather. The apparatus consists of a portable stove, constructed of plate iron, and is surmounted by a fan which is driven by a belt from a three horse-power portable steam-engine. The fan draws all the heated air and gases from the coke fire, together with a volume of warmed air, which passes through a chamber surrounding the inner chamber of the stove, and blows the hot current, at a temperature of 400° Fahr. or more, into the dryer. This resembles in general shape a straw elevator, consisting of a sheet-iron trough six feet in breadth, twenty feet long if mounted on wheels as a portable carriage, or forty or fifty feet long if a fixture. The trough is raised at one end at a low angle, so that hay fed in at the upper end farthest from the stove shall slowly travel to the lower end near the stove, this being assisted by a reciprocating motion given to the bottom of the trough. A ridge of triangular section, running along the middle of the trough, divides it into two almost semicircular channels, so that the hay passes down in two streams; the hot air issues through two slit apertures, one on each side of the base of the middle ridge, and for the entire length of the machine, and the hay is kept continually stirred and lightened up, over the hot blast, by a number of small iron stirrers contrived to imitate the action of forks worked by hands. The London *Times*, in an article on this subject, remarks of the experiment of Mr. Gibbs, that partly made but wet hay passed through the machine was converted at once

into a thoroughly dry condition for the stack, and that spoiled and musty hay was dried into hay of fair apparent quality and pleasant fragrance; also, that freshly cut grass, saturated with rain from a heavy thunder-shower, was dried into hay of first-class color, possessing the rich malt odor of well-made hay. Mr. Gibbs, in bringing his invention before the public, claims that this new hay-dryer is as portable as a threshing-machine, and as quickly set to work; that, besides dealing with first and second crops of hay, it will dry all kinds of grain in the straw, and fit it for being threshed out at once if wished. He says one ordinary portable engine of eight or ten horse-power can dry and thresh out at the same time. The machine can be driven by either steam or water power, or by horse gear; and, in whichever way, it will save the labor of five or six men. Being thus a labor-saving machine, its use is not limited to that of final resource when other means fail, but it is available during every dull day of harvest for finishing off rapidly the most advanced of the hay or grain crop, and thus expediting as well as insuring the gathering. If three or four farmers purchased one such machine among themselves, and hired it out to each other in turn, those of them who did not need to use it would get ten per cent. on their share of the cost, while those who did need it would in all probability save the whole of their outlay the first season. The objection that all would want it at once is not so great as it seems, because it is very seldom that the farmers of a neighborhood have their crops in exactly the same state of forwardness simultaneously. Every practical man knows that in some seasons he has suffered great loss and inconvenience by bad weather, while his neighbors, from being a little earlier or a little later than himself, have saved their crops in good condition; in other seasons the case has been reversed; he has been fortunate and they have been caught. Moreover, it has been found that when half-made hay had been left out untouched in the rain for three or four weeks, until some parts were black and apparently worthless, the drying process restored the whole to a fair marketable quality. Hence, each farmer could safely wait his turn, so long as there was the satisfactory certainty of being able thus to complete his harvest. According to Mr. Gibbs's calculation, the total expenses, allowing for outlay and for wear

and tear, does not exceed seven or eight shillings per ton.—2 *A*, XX., 64.

THE NEW PHYLLOXERA REMEDY.

La Nature, in a late review of the researches of M. Dumas relative to the practical efficiency of the alkaline sulpho-carbonates as destroyers of the phylloxera, affords us the following information upon the philosophy of the operation of this class of salts: The sulpho-carbonates of the alkalies are produced by calcining their respective sulphates with carbon, by which the mono-sulphide is produced, and agitating a concentrated aqueous solution of this with carbon disulphide. The sulpho-carbonates obtained as here described are free from disagreeable odor, are not dangerous to handle, are non-inflammable, and comparatively stable. In the presence of acids, however, even of the weakest, and notably when acted upon by the carbonic acid of which a moist, arable soil invariably contains a certain quantity, the sulpho-carbonates are decomposed into carbonates, with the liberation of carbon disulphide and sulphuretted hydrogen, both of which, and especially the first, are known to be highly efficient insecticides. It has been found that it is not only necessary to destroy the insects upon the vines and roots, but likewise to poison the earth in the vicinity of the same, and render it uninhabitable by them. For this purpose the sulpho-carbonates seem to be admirably adapted, inasmuch as, by their tardy decomposition, they furnish a slow but constant supply of the poisonous gases for some days. Experiments have shown that 1442 grains of the sulpho-carbonate of potassa will exterminate the insects from 198 to 284 cubic feet of earth, killing not only the phylloxera, but likewise the larvæ of larger insects. To apply the remedy, it is recommended to remove the earth from the foot of the vine about a foot deep and sixteen inches broad, into which is to be poured five or six quarts of water mixed with six or eight quarts of the sulpho-carbonate solution at 40° Baumé. When the liquid is well absorbed the hole is closed, and the same process gone through on another vine. By following this method the penetration of the solution to the deepest roots is insured. Another method of application proposed by M. Dumas is to mix the sulpho-carbonate with twice its weight

of slaked lime, and to strew the powder thus obtained upon the soil wherever required.

RAVAGES OF PHYLLOXERA.

Among the various methods employed most successfully in France to prevent the ravages of the phylloxera, is the application of the sulpho-carbonates as originally suggested by M. Dumas. The sulpho-carbonate of potash has been experimented with most generally, and it is maintained that in addition to the destruction of the pest, it serves as a valuable manure to the plants, greatly increasing their vigor. More recently sulpho-carbonates of sodium and of barium have been tested, the former proving to be in every respect equal in efficacy to the potassium salt. In some respects it was found that the salt of barium was even better than the other, as it is quite reasonable in price, and as a mineral manure its action is much slower and more permanent than that of the other.—6 *B*, *July* 17, 1876, 213.

LATEST CONCLUSIONS RESPECTING PHYLLOXERA.

The most recent conclusions by Dumas in regard to the subject of the phylloxera, or grape-vine louse, and its remedies, are as follows: First, sulpho-carbonate of potassium is a rapid insecticide, the only one which surely destroys the insect at the roots, and also supplies to the vine a strong reconstituent element; second, sulpho-carbonate of sodium offers the same advantages, used only as insecticide; third, sulpho-carbonate of barium, being anhydrous and little soluble, is recommended for its resistance to the action of oxygen and of carbolic acid, so that it is a poison less prompt, but more durable in effect; with regard to the winter eggs, fourth, the heavy oil of gas-tar, and especially the oil called *anthracene*, seems to be best for washing the stocks and destroying the eggs; fifth, the treatment with tar for the stocks and sulpho-carbonates for the roots should be effected especially in February and March.—18 *A*, *March* 10, 1876, 658.

CARTRIDGES FOR THE DESTRUCTION OF FIELD MICE BY FUMIGATION.

According to Dr. Nessler, the cartridges recommended for destroying field mice by fumigation may be prepared by

dissolving twelve parts of saltpetre in twenty-four parts of hot water, and mixing well with thirty parts of sawdust and seven parts of coal-tar, and drying in the air. This powder may then be made up with starch-paste (ten parts of starch to ninety parts of water) into a mass that can be formed into rods about four tenths of an inch thick and one inch long, which should be well dried, and sprinkled with melted sulphur. The mixing of the powder and making up of the mass with starch-paste is readily accomplished in a petroleum barrel, containing ten to twelve one-pound iron balls, and capable of being rotated on an axis passing through it lengthwise. The rods may be formed most rapidly by pressing the mass in sheet-iron moulds having a number of compartments of the proper size. Several thousand, it is said, can be made by a practiced hand in an hour. After drying, they should be spread out, and by means of a broom sprinkled with fused sulphur.—5 *C*, XXXII., 255.

MEANS FOR DESTROYING THE SIBERIAN MARMOT.

Among the smaller animals most injurious to vegetation in Siberia is a small marmot known as the soulish (*Spermophilus citillus*), closely allied to the species so common in Minnesota, Wisconsin, and Iowa, in the West, called there gopher, thirteen-lined squirrel, prairie squirrel, etc. In the department of Jekaterinoslaw they have lately become so abundant as to constitute a positive pest, and an order has been issued requiring each inhabitant to furnish a certain number of heads under penalty of a fine. In 1873, in five counties alone rewards were paid for the destruction of nearly six millions of these animals. By energetic measures of this kind alone has it been possible to prevent the almost total destruction of the crops.—3 *C*, XXXVI., 724.

THE FODDER VALUE OF APPLES.

In his investigation of the fodder value of apples, Professor Storer confirms the observations of other chemists, to the effect that apples are very poor in nitrogen. The flesh of Baldwins and Russets yielded 15.7 to 17.5 per cent. of dry organic matter (the rest being water and mineral matters), and only 0.21 to 0.27 per cent. of albuminoids. Apple pomace contained 22.3 per cent. of dry organic matter, and 0.98 per cent.

of albuminoids. Leaving the water out of account, the dry matter of the flesh of apples contains 1.43 per cent. of albuminoids, while the dry matter of potatoes has 8.54, and pumpkins 17.32 per cent. of albuminoids. From these facts two interesting conclusions are to be drawn. First, the small amount of nitrogen explains at least one reason for the low value of apples for feed and for manure; and, second, to make economical fodder from apples or pomace, food rich in nitrogen should be added. In this way not only the sugar, but also the pectose, of which apples are largely composed, may be economically utilized as food.—*Bulletin Bussey Institution*, I., 339.

THE TASTE OF TURNIPS IN MILK AND BUTTER.

It is stated, upon German authority, that the unpleasant taste imparted to milk and butter by feeding turnips, etc., may be removed by simply throwing into each pan of milk of four to five quarts as much saltpetre as will lie on the point of a knife, when a gelatinous mass will separate from the milk and settle to the bottom.—9 *C*, XIII., 107.

PRESERVATION OF HOPS.

Exhaustive experiments have demonstrated that hops, packed when fresh by means of a hand-press in strong, suitably constructed metallic boxes, and sealed up hermetically, can be preserved in any cellar with a temperature not above 48° or 50°, without manifesting the least inferiority to fresh hops in color, odor, or weight; and the beer made with them in summer is said to equal winter beer in flavor and fineness. —13 *C, December* 15, 1875, 1559.

NEW FERTILIZING MATERIAL.

Cabien recently called the attention of the Paris Academy of Sciences to the hitherto entirely neglected source of fertilizing material in the deposits left by every ebb-tide. He asserted that, after the detritus had been suitably ground, he obtained a powder consisting of calcareous phosphates, which, when mixed with an equal amount of liquid and solid fecal matter, afforded a manure containing 30 per cent. of easily soluble phosphates, 20 per cent. of nitrogen, and only 12 per cent. of insoluble ingredients, being as rich in nitrogen

as Peruvian guano, and richer in phosphates.—3 *C*, *November* 1, 1875, 884.

POSSIBILITY OF PREDICTING THE COMING HARVEST.

Marié Davy, having studied the influence of the weather upon the vegetation in 1875 and 1876, concludes that there occur in the life of a plant two well-marked phases: first, the plant assimilates, and, second, it applies the reserved material to the formation of the seeds. In comparing the seasons of 1873, 1874, and 1875, he states that the study of the hygrometer and the evapometer, supplementing as they do the temperature, rain, and light, leads to the conclusion that if we have the meteorological data for the weather succeeding the time of blossoming of the plant, we can, according to the locality, estimate the probable value of the harvest that is to follow.—19 *C*, 1876, 100.

J. PISCICULTURE AND THE FISHERIES.

REPORT ON THE MARITIME FISHERIES OF FRANCE, 1874.

The report on the maritime fisheries of France for the year 1874 has just been published, showing that their general value amounted to about 73,000,000 francs, being nearly six and a half millions less than in 1873.

So far as the cod are concerned, there was a larger yield than before, although there was a reduction of twenty-five in the number of vessels in the fishing fleet. The herring-fishery was much inferior, nearly half of the general deficit relating to this fish. Among the causes of this decrease are named, first, a diminished demand for the fish; second, the later period at which the vessels started out for the fisheries; and, third, the abundance of fruit in the maritime districts, thus materially reducing the use of the herring. This decreased demand is considered a circumstance to be regretted, certain establishments which formerly consumed large quantities of herring now dispensing with them, especially in Alsace and Lorraine. There is no reason to believe that the fish have become any scarcer, nor that the means at the command of the fishermen are insufficient to secure a much larger yield; in fact, the use of cotton for nets instead of hemp, and improved apparatus generally, allow a greatly increased percentage of captures in proportion to the number of men.

Improved methods in the preparation of the herring are now strongly urged, so that an increasing demand may be secured, and thus an important industry be maintained at its utmost development.

The sardine-fishery of 1874 was also much less than that of previous years, in consequence of the diminished numbers on the coast.

Much satisfaction is expressed in the official report at the improvement in the department of oyster-culture, the production of Arcachon alone being nearly 82,000,000, or nearly double that of 1873, with a corresponding reduction of nearly one half in price.

The actual number of men employed in 1874 amounted to 67,029, and of vessels of all kinds to 20,399, with an aggregate of 102,083 tons.—*Revue Maritime et Coloniale.*

REPORT OF BUREAU OF STATISTICS.

The annual report of Dr. Young, Chief of the Bureau of Statistics of Commerce and Navigation, for the fiscal year ending June 30th, 1875, has been published as a portion of the report of the Secretary of the Treasury, and forms an octavo of about 1100 pages. As usual, it is divided into three parts: first, Commerce; second, Immigration; third, Navigation. Under the head of commerce is given the usual series of tables of domestic and foreign imports and exports, with the duties levied, home consumption, shipments of domestic and foreign commodities and lumber, etc.

The products of the American fisheries and the imports from foreign ports are also given in the series of tables. The value of the American whale-fishery for the fiscal year mentioned is given at $2,841,002, this including 1,090,951 gallons of sperm and 1,414,186 gallons of whale oil, 328,217 pounds of whalebone, etc. The cod-fisheries are estimated at 756,543 hundred-weight, with a value of $3,664,496; the herring-fisheries at 527,633 hundred-weight, valued at $2,655,623. The entire yield of the American fisheries other than the whale-fishery is placed at $10,747,579, and the total value, including the whale-fisheries, at $13,588,581.

Comparing these tables of the whale-fisheries with those given by Messrs. Bartlett and Son, of New Bedford, for the actual imports during the year 1875, we find, according to the last-mentioned authority, that there were taken 42,617 barrels of sperm-oil, 34,594 barrels of whale-oil, and 372,303 pounds of whalebone.

GLOUCESTER FISHERIES FOR 1875.

The *Cape Ann Family Almanac* for 1876, published by the Gloucester *Telegraph*, contains some interesting notes in regard to the progress of the fisheries of that noted town. The extent of these may be judged from the fact that the total value of the fisheries for 1875 for the port of Gloucester amounted to $3,909,500, that of the whole district of Gloucester being $4,624,000. The whole number of vessels em-

ployed was 376, of which 108 were employed in the mackerel-fishery.

The most important item of the fisheries was that of the Georges cod-fishery, producing $1,021,000; next is the Banks cod-fishery, valued at $998,000; while the Bank halibut-fisheries were valued at $507,000.—*Cape Ann Family Almanac.*

CONNECTION OF METEOROLOGY AND HERRING-FISHERIES.

For some years past the Meteorological Society of Scotland has been endeavoring to ascertain the connection, if any, between the physical conditions of the atmosphere and the water of the sea and the appearance of herring on the coast of Scotland, this fishery being, as is well known, a very important interest in that country, and one employing a large capital and many men. The results of their labors, after a careful consideration of all the facts and conditions, may be summed up in the proposition that the "take" of herring is most abundant when and where the temperature of the sea is lowest. It was found that the temperature of the sea for the east coast of Scotland from the middle of August to the close of the fishing season was continuously and considerably higher in 1875 than in 1874; and that the catch of herring was continuously and considerably lower during 1875 than during the same period in 1874. When the temperature at the surface of the sea was high, the fish were found in the deeper parts of the water, preferring the lower to the higher temperature.

When a thunder-storm has prevailed on any of the days devoted to fishing, a good "take" of herrings may be expected, but on the following day few if any fish are caught on that part of the coast, unless at the extreme verge of a deep part of the sea, as if the fish were retreating thither. To settle these points on a more definite basis, and to give greater precision to their investigations, the Meteorological Society of Scotland desires the fishermen generally to observe the temperature of the sea at the surface and also at the depth at which the fish strike the coast, the amount of trouble involved in this being very incommensurate with the practical results that promise to be obtained therefrom. By a somewhat similar series of observations, prosecuted by Von Freeden, of

Hamburg, it was ascertained that northwest winds are best for large catches of herring, and northerly winds better than southerly, westerly better than easterly, also that moderately strong winds, sufficient to ruffle the surface of the sea, are better than calm weather, and light winds almost as unfavorable as stiff breezes. It is not impossible that, before long, the herring-fishery may be regulated by the thermometer, and that the net will be shot, not at random, as heretofore, but with an almost absolute certainty of finding the fish.

In further illustration of the influence of temperature on the herring-fishery of Scotland, we learn that during the week ending August 19th last the temperature of the water off the coast of Northumberland kept at from 58° to 59°, but that on the 21st it fell to 55°, and on that day herring were caught for the first time. Since then the shoals have been so great that several vessels have sustained heavy losses by the weight of the herring carrying the nets to the bottom.

During the whole of the warm weather of the past summer the catch of herring was very light, and it was not until the change of temperature that they came within range of the nets.—12 *A*, *August* 24, 31, 352, 381.

POTOMAC RIVER FISHERIES.

A writer in the Washington *Evening Star*, commenting upon the rapid decrease in the fisheries of the Potomac River, is disposed to assign the cause, as do many others, to the combined action of the gill-nets and shore seines which break up the schools of fish when on their way to the spawning-grounds, thus preventing the depositing of their eggs under circumstances favorable to their development. He strongly urges the propriety of having the deep channel of the Potomac marked out, and the introduction of nets of any kind therein prohibited under some stringent enactment, this channel to be wide enough to permit sea-room to vessels sailing against the wind—half a mile is suggested—and so buoyed and staked out that its location shall be unmistakable.

A similar action in the harbor of New York has resulted in preventing the destruction of the fish, and allows them to pass up in sufficient numbers to perpetuate their species.—*Evening Star*.

SEAL-FISHERIES OF 1876 ON THE GREENLAND COAST.

The seal-fishery off the coast of Greenland, as prosecuted by vessels from Dundee, Scotland, has proved to be more remunerative during the spring of 1876 than that of the preceding year, eleven vessels having taken 53,776 seals and 578 tuns of oil. In the preceding season twelve vessels took 45,295 seals, yielding 455 tuns of oil. The total value of this fishery for 1876 amounted to £34,332; that of 1875, to £27,026.

The Norwegian Greenland fisheries for the year have also been very successful. One peculiar feature of the year has been the number of old seals taken early in the season, showing that the work began too soon, as the young must have been very small.

CLOSE TIME FOR SEALS IN THE NORTHERN SEA.

Negotiations under way between the governments of Great Britain and Norway in reference to the time for the capture of seals on the Greenland coast have at last been consummated by the adoption of an Order in Council fixing the 3d of April in each year as the date before which no British subject shall kill or capture seals within the specified area. It is hoped that these restrictions, if fully carried out, will soon put an end to the barbarous destruction of infant seals.

REPORT ON ALASKA SEAL ISLANDS.

The subject of the Alaska fur-seal fishery is one of considerable importance in view of the revenue derived by the United States from the Alaska Commercial Company for the rent of the islands. Since the lease to that company numerous complaints have been made from time to time of its management; and in 1874 an act was passed to appoint a commission to visit the North Pacific with a view of determining whether there are other localities where the fur-seal can be found, and a clause was introduced directing the investigation by an officer of the navy into the management of their trust by the Alaska Commercial Company, and their treatment of the natives.

Mr. Henry W. Elliott was put in charge of the former object of the expedition, and Lieutenant Maynard was detailed

for the latter. Mr. Elliott's report was published some time ago; that of Lieutenant Maynard has just made its appearance under a call from the House of Representatives of the 14th of December.

MENHADEN-FISHERY IN 1875.

From a recent report of the United States Menhaden Oil and Guano Association, presented at its third annual meeting at Providence on the 12th of January last, we learn that the number of factories in operation in 1875 was sixty, being four less than in 1874; that there were 2633 men employed, an increase of 194. The number of sailing-vessels was 304, an increase of 21; the number of steam-vessels, 39, an increase of 14. The fish caught in 1874 amounted to over 463,000,000, or 1,877,767 barrels, an increase over the number in 1874 of 734,840 barrels. Of oil, 2,681,487 gallons were made in 1875, and 43,620 tons of guano. The capital invested for 1876 is $2,650,000, an increase of $150,000 over that of the previous year.

Reference is made to the announcement by the Hon. S. L. Goodale, of Saco, Maine, of a practical application of menhaden in the form of a fish-extract for medicinal and culinary purposes; this substance, as derived from menhaden, being considered especially nutritious and palatable. This promises to add a very great element of value to the menhaden industry, without in any way affecting the availability of the crop for the manufacture of oil and scrap.

As the result of experiments of shipments of scrap during 1874, it was announced that 4000 tons had recently been forwarded to Liverpool and Queenstown. It was resolved that all guano and scrap manufactured by members of this association shall be sold at the weight taken at the factory of the seller.

NEW USE FOR THE SCRAP OF THE MOSS-BUNKER.

The applications of the moss-bunker, menhaden, or pogy, a well-known fish of the herring family, in the manufacture of oil and guano are well understood. The fish when taken for this purpose is first steamed and then subjected to a heavy pressure, by which the oil is squeezed out, and the refuse or scrap left behind. The oil is used in the manufacture of

soaps, the dressing of hides, etc., while the scrap is converted into fertilizers of various kinds.

It is now stated that a new use has been found for this scrap, namely, that of employing it as a source whence a large amount of ammonia and other nitrogenous products may be obtained. This is accomplished by a certain process of treatment with lime. It is proposed to prepare from this substance a sulphate of ammonia, by treating it with sulphuric acid of the refineries of petroleum. Doubtless other chemical products will also be attempted.

The menhaden is also put up in oil in numerous establishments in New Jersey, and sold as the American sardine, ocean trout, etc., and sometimes is also put up in spices and pickled.

Mr. Goodale, of Maine, has recently suggested another application of this fish, in the preparation of a meat juice, which he claims to be extremely palatable and nourishing, quite equal in this respect to any of the articles of a similar kind known in the trade, while at the same time the value of the fish for oil and guano is undiminished.—*Letter of Dr. Squibbs.*

UTILIZING THE OFFAL OF CODFISH ON THE GULF OF ST. LAWRENCE.

M. Levy has lately started an establishment at the French island of St. Pierre, in the Gulf of St. Lawrence, for the purpose of utilizing the gurry and offal of the codfish, etc., taken on the banks of Newfoundland. All the heads, entrails, etc., are gathered in, and after the extraction of the oil, the bones are converted into gelatine and superphosphates. There are two factories of a similar character in Norway, one at the Loffoden Islands and the other at Christiania.—8 *B, August* 21, 1875, 192.

REPORT OF THE COMMISSIONER OF FISHERIES OF CANADA, FOR 1875.

The report of the Commissioner of Fisheries of Canada, for the year ending December, 1875, has been recently published by the Dominion authorities, and embraces an account of the general yield of the fisheries for the year, imports and exports of fish, the staff of officers, the methods taken for multiplying the whitefish, salmon, etc., the development of

the waters, and a consideration of the oyster-beds, lobsters, etc. According to Mr. Whitcher, the product of the fisheries generally was less than that in 1874, this being especially true of the salmon and lobster. The total value of the production for 1875 was $10,347,886; the value of the exports during the fiscal year was $134,753. Notwithstanding this decrease, the Commissioner expresses himself as satisfied with the result, the fishing population having enjoyed prosperity, with a good prospect of increased yields in the future. According to the report, the Dominion government has now in operation seven establishments for the artificial propagation of fish. In addition to those at Newcastle, Gaspé, Restigouche, and Miramichi, three others have been erected; at Sandwich on the Detroit River, at Tadousac on the Saguenay, and at Bedford on the Sackville River, not far from Halifax. The total number of young salmon distributed from the hatching of 1874 was 1,700,000, and a much larger number is hoped for hereafter.

REPORT OF THE FISH COMMISSIONERS OF MAINE.

The Fish Commissioners of Maine have published their report for 1875, being their ninth annual report, and, as might have been expected, much space is occupied therein by the subject of the salmon and land-locked salmon, in regard to which they have made the usual progress by means of the hatching establishments at Bucksport, Grand Lake Stream, and elsewhere. They refer to the remarkable scarcity of salmon on the coast during the year 1875, a condition prevailing both in the United States and throughout the British Provinces, and they suggest that the much greater abundance during the year before indicates something similar to what we see in certain fruit crops, which usually show a regular period of abundance and scarcity in successive years. They say that very possibly the salmon have a two years' period of return to their native waters for the purpose of spawning, instead of one — a suggestion heretofore made by good observers.

Of the fry of the salmon, 700,000 were distributed, 100,000 being those of the California species. The growing interest in the land-locked salmon has also been responded to by the Maine Commissioners. During the past year many eggs

were secured at Sebec Lake, and a still larger number at Sebago and Grand Lake Stream, and, it is to be hoped, with satisfactory results.

The distribution of black bass has been continued by the Commissioners, and they warmly recommend this fish for waters already infested with pickerel, which they can successfully resist, even if they can not exterminate them.

Reference is also made to the blue-backed trout, *Salmo oquassa*, and to the land-locked smelt, and the propagation of both strongly urged. A good deal has been done by the Commissioners in reference to distributing the former fish, now confined to the Rangeley lakes and other streams and ponds of the state.

The subject of fish-ways is one that the Commissioners consider requires further legislation, in view of the strenuous and hitherto successful resistance to the laws already enacted by mill-owners on certain streams of the state.

REPORT OF THE FISH COMMISSIONERS OF NEW HAMPSHIRE.

The report of the Fish Commissioners of New Hampshire, made to the Legislature at the June session of 1876, gives an account of the work done by these gentlemen in the performance of their trust. The small amount of money at the command of the Commissioners prevented the accomplishment of all that was desirable, but they have made some progress in the distribution of black bass, and in introducing the wall-eyed pike. They report a considerable amount of progress in the restoration of salmon to the waters of the state, and look forward to a future increase in the supply as a matter of much interest to the people.

TENTH REPORT OF THE MASSACHUSETTS FISH COMMISSIONERS.

Of the series of reports of the Fish Commissioners of the several states, none are more important than those published by Massachusetts, of which the tenth, for 1875, has been issued.

Upon the much-contested question of the efficiency of the fish-way at Hadley Falls in permitting the passage of shad, the Commissioners maintain that the problem has been solved satisfactorily in the affirmative; and as the result of a careful examination, they state that a great number of fish, such

as suckers, black bass, etc., have passed through, and that quite a number of yearling shad were among the number, with only one mature fish.

Although the dam has been in use for some time, the fact that no shad for several years were seen to ascend it was seized upon as an argument in opposition to the assertion of its efficiency. This, however, was met by the theory, now well established, that anadromous fish ascend to the point whence they commenced their downward journey to the sea, and no higher, and that consequently, as no shad had been hatched or placed as young fish in the water above Hadley Falls, none would attempt to go above as mature fish. But as for two years past young shad have been hatched below the dam and carried to the waters above, the Commissioners think there is no reasonable doubt that the yearling shad in question were of the number. In another year we may, therefore, anticipate the passage of adult fish.

The other fish-ways in the state, as on the Merrimac, the Neponset, the Taunton, and the Palmer, have also proved to be efficient. Shad-hatching in 1875 was conducted as heretofore on the Merrimac, the whole number of shad taken therein amounting to 1433, and of spawn to 6,670,000. The catch of shad during the past year in the Merrimac was larger than it had been for twenty-five years previous, they being so abundant that at Newburyport they were salted and barreled as in olden times. This is considered by the Commissioners as very satisfactory proof of the beneficial results of artificial culture.

The report is accompanied by a valuable sketch of the progress of fish-culture in New England, and also a bill proposed for the regulation of the shore fisheries of the state.

TENTH REPORT OF THE FISH COMMISSIONERS OF CONNECTICUT.

The tenth report of the Fish Commissioners of the State of Connecticut was presented to the Legislature at the May session; and as giving the history of the efforts of the first decade in the restoration of fish to the waters of the state, they take occasion to review what has been done from the beginning under state patronage.

The Commissioners remark that Massachusetts, in 1856, was the first state to appoint Fish Commissioners to consider the subject of artificial propagation, but that no practical result followed. In 1864 New Hampshire and Vermont, in 1865 Massachusetts, and in 1866 Connecticut, appointed Commissioners to investigate the whole subject; and on the 26th of February, 1867, a meeting of Commissioners was held in Boston, and the organization of "The New England Commissioners of Inland Fisheries" was formed, with the special object of co-operation in restocking the Connecticut with salmon and shad. In this New Hampshire was to procure and distribute impregnated ova of salmon and shad in the head-waters of the river. Vermont and Massachusetts were to build suitable fish-ways over the dams to the spawning-grounds, and Connecticut was to abolish gill-nets, stake-nets, and pounds in the river and on the Sound. These measures of co-operation were carried out as fully as the various circumstances would permit.

The first experiments in the artificial hatching of shad were initiated by Seth Green at Holyoke in July, 1867. In the following winter the first lot of salmon fry, about 20,000, were placed in the head-waters of the Connecticut. The operations in New England generally and those in Connecticut especially in succeeding years are enumerated.

As will be noticed by a perusal of this very important report, no state has done more than, if so much as, Connecticut for the culture of the useful food fishes; and the result is already seen, as far as the Connecticut River is concerned, in the existence of an actual glut of the market with shad.

So far no positive return has been experienced in regard to salmon, but this was not expected before the year 1876, and possibly 1877. We hope the next report of the Commissioners will exhibit a measure of success in this direction that will satisfy the most doubting skeptics.

EIGHTH REPORT OF THE FISH COMMISSIONERS OF NEW YORK.

The eighth annual report of the Fish Commissioners of the State of New York, for the year ending December 31, 1875, has made its appearance. In regard to shad, it is stated that nearly 4,500,000 young fish were turned loose into the

Hudson River; and the yield of mature shad shows a fair increase in the number, and a very decided effect upon the price, large fish being readily procured in New York and in the towns of the state for twenty to twenty-five cents each—a rate which had not been known for twenty years previous.

The Commissioners continue their complaints of the violation of the law by fishermen, and state that the yield would otherwise have been very much greater. They urge that no fishing shall be done from Saturday night until Monday morning, and that the raising of all nets fastened to stakes be insisted upon during that period.

In reference to shad deposited in the tributaries of Lake Ontario, they remark that full-grown fish of marketable size have frequently been taken, and that in all probability the supply would be abundant but for the destruction wrought by the eel-weirs, which they consider among the most injurious agencies in interfering with the successful prosecution of the work. Indeed, according to the report, the shad artificially introduced into Lake Ontario have multiplied until now they amount to millions, and the fishermen think that if they continue to increase as they have done, the fish will be so abundant as not to repay them for their labor.

The Commissioners report that 304,000 California salmon, received from the United States Fish Commission, have been distributed during the year. They also detail the result of experiments in regard to the artificial hatching of sturgeon, which were successfully made by Mr. Seth Green. The eggs are sticky, as in the perch, and required some peculiar manipulation for their treatment, and a special apparatus was devised for the purpose, which it is thought will accomplish the object. The time of growth proved to be a hundred hours, in water at a temperature of from 67° to 74°.

The Commissioners continue to call attention to the destructive influences of fish-weirs and other agencies, and invoke legislation for their regulation, if not for their entire prohibition.

The report contains the statistics of the hatching of shad, as also the distribution of fish from the state hatching-house, and concludes with a general summary of the history of fish-cultural operations in other states.

FIFTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW JERSEY.

The fifth annual report (for the year 1874) of the Commissioners of Fisheries of the State of New Jersey contains a notice of the work done during that year. The report refers in appropriate terms to the death of Dr. J. H. Slack, one of the oldest Commissioners of the state, and one of the most successful fish-culturists in this country. In reference to shad—the most important fish of the Delaware River—the report states that the catch during the year 1874 was 50 per cent. more than in 1873, and that the average weight of the fish was considerably increased. This was ascribed to the better observance of the fishery laws for the past three seasons, especially that requiring a weekly close time of thirty hours, and also to the removal of fish-baskets in the Delaware, by which great numbers of young fish had heretofore been destroyed. The Commissioners urge the enforcement of the law in reference to this class of obstructions, and others of greater or less moment. A very important feature in the report consists in the reprint of the laws enacted by the Legislature of New Jersey, in reference to the concurrent rights of New Jersey and Pennsylvania over the fisheries of the Delaware; and also the agreements on the subject entered into by the representatives of the two states at various times.

SIXTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW JERSEY.

The sixth annual report of the Commissioners of Fisheries for the State of New Jersey, for the year 1875, has also been published, giving an account of what has been accomplished under their auspices. For greater convenience, they divided the state into the tidal or southern department and the non-tidal, each having special representatives in the board.

They are happy to state that, in consequence of the care bestowed upon the fishing interests by the enactment of laws and their enforcement by the Commissioners, the catch of shad is becoming greater in numbers and of larger size in each successive year, the fishing in the bay having been extraordinarily successful in 1875. Two hundred and fifty shad

were taken at one drift, and the average per net was double that of the preceding season.

The quality fully corresponded with the increased numbers, shad of eight pounds having been captured. Notwithstanding the great increase, the fish kept up in price satisfactorily; and the fishermen themselves admitted that the improvement in the fishing is due to the enforcement of the laws, and are much more ready to accept them than formerly; in fact, every where the report confirms the statements of the increase referred to.

The Commissioners make a distinction between the work done by the gilling-nets and the shore or sweeping seines. They also state that the shad-fishing commenced unusually late in 1875, and that the fish entered the bay in immense numbers, but were kept in the brackish water by the continued cold weather, and were taken there in great numbers by the drift nets. The shore fishing did not commence until the 26th to the 28th of April, more than two weeks later than usual.

Reference is made to the concurrent action of New Jersey and Pennsylvania in regard to the hatching of shad in the Delaware River, the total number hatched at the several stations amounting to 1,400,000, at a cost of $937.20.

ACTION OF THE KENTUCKY FISH COMMISSIONERS.

Among the commissions appointed in the different states having for their object the protection and increase of fishes throughout their borders, none promises to be more enterprising and efficient than that of Kentucky, established by an act of March 20, 1876. The number of Commissioners is much larger than usual, being one for each Congressional district, or ten in all. The Executive Committee consists of Messrs. P. H. Darbey, John A. Steele, J. H. Bruce, Dr. S. W. Coombs, and Pack Thomas, the latter gentleman being president and executive officer of the board.

An address has just been issued by the Commissioners to the people of Kentucky, publishing the act, and making many suggestions in regard to the future of the Commission and the results to be attained.

Extracts from various reports of National or State Commissioners are given, including the whole of the annual re-

port of the Commissioners of New York for the year 1874, with its many interesting illustrations of hatching establishments, fishes, etc.

CONVENTION OF WESTERN STATE FISH COMMISSIONERS.

A convention of the State Fish Commissioners of Ohio, Michigan, and Wisconsin met at Detroit on the 7th of February, for the purpose of determining upon conjoint legislation for the protection of the fish of the waters belonging to these several states. Among those present were Governor Bagley and Mr. George Clarke for Michigan, William Welch for Wisconsin, and Mr. E. B. Potter for Ohio. It was determined to recommend to the respective state legislatures the passage of laws prohibiting the discharge of refuse from distilleries, coal-oil refineries, or gas-works into any of the lakes or rivers; second, to prohibit the catching of whitefish and lake trout in pound-nets during the period from November 15 to September 10; third, to prevent the catching of any fish with gill, drag, or float nets within ten miles of the shores of any of the great lakes; fourth, to prohibit the catching, killing, or offering for sale of whitefish of less than one and a half pounds' weight; fifth, that pound-nets shall not extend over one mile from a base-line of seven feet of water into the lake, provided that they may, in the bays and indentations along the shore, extend one and a quarter miles from such base.

FIRST REPORT OF THE IOWA FISH COMMISSIONERS.

The first report of the Iowa Fish Commissioners, for the years 1874 and 1875, gives an account of their organization for the purpose of carrying out the trusts confided to them.

Among the first business transacted by them was the establishment of a hatching-house near Anamosa, under direction of B. F. Shaw. In this much work has already been done in the way of hatching out spawn of California salmon and other useful fishes. The total amount of spawn handled and of fish distributed by the state, consisting of California salmon, Penobscot salmon, etc., was nearly two millions, of which a good account, it is hoped, will be received in future years.

SECOND REPORT OF THE COMMISSIONERS OF FISHERIES OF WISCONSIN.

The second annual report of the Commissioners of Fisheries of the State of Wisconsin for 1875 has been published. It opens with the mention of some interesting facts in connection with the fisheries of Lake Michigan, and suggests the appointment of Dr. Hoy, one of the Commissioners, to prosecute similar inquiries on a large scale during the present year. The fisheries of the lakes, in the opinion of the Commissioners, have fallen off in 1875 by at least one fourth; and if this rate be continued but a few years, this great interest of Wisconsin will become practically exhausted. They therefore urge strongly the necessity of immediate action in regard to measures for the protection of the various species of fishes of the state for a few years, and the importance of efforts to multiply them and add new ones on the largest possible scale.

The Commissioners, owing to the scanty funds at their disposal, have been unable to accomplish much in the way of the active prosecution of their duties beyond the laying of foundations for future judicious work. One of their enterprises was the collecting of the eggs of the Mackinaw trout, of which it was found impossible to secure ripe spawn in any considerable quantity. Some eggs of the whitefish, however, were taken, as well as of the lake herring, which were hatched out at a temporary hatching-house improvised by the Commissioners at Pensaukee, on Green Bay.

SECOND REPORT OF THE FISH COMMISSIONERS OF MINNESOTA.

The Fish Commissioners of Minnesota have presented their second annual report, through Dr. R. O. Sweeney, the chairman, giving an account of what they have done in the way of hatching out the eggs of California salmon, the Atlantic salmon, and the land-locked salmon, furnished to them by the United States Fish Commission, specifying also the localities in which the young were planted after being developed.

They propose to continue the work, if suitable provision can be made, until every lake and stream in the state shall be made to yield its full proportion of food. They estimate the water surface of the state to be over 1,600,000 acres;

and making the very moderate allowance of a possible annual yield of ten pounds of fish to each acre, worth five cents per pound, the sum of $80,000,000 would represent the actual income to the state from this source, which is more than equal to a two years' yield of the wheat crop in Minnesota.

The Commissioners also propose to do what they can for the multiplication of whitefish, Lake Superior trout, eels, etc.

ARKANSAS FISH COMMISSIONERS.

The State of Arkansas has passed an act, approved November 29, 1875, for the appointment of three Commissioners to consider the subject of introducing sea-fish into the rivers of Arkansas, and the introduction of new varieties of the fresh-water species, as well as the protection of fish generally in Arkansas waters, and report on the same to the next session of the Legislature. The gentlemen appointed as Fish Commissioners were Messrs. M. H. Dunn, of Pine Bluffs, J. R. Stedman, of Little Rock, and N. B. Pearce, of Fayetteville.

BIENNIAL REPORT OF THE CALIFORNIA FISH COMMISSION.

The biennial report, for the year 1874–75, of the California Fish Commission has been published, and gives an account of the labors of Messrs. Redding, Throckmorton, and Farwell in the administration of the trust confided to them by the state. Referring to their previous report for the account of an unsuccessful experiment at introducing fresh-water and marine fish of the Atlantic slope to California by means of an aquarium car, they have the pleasure of announcing the entire success of the renewed effort on the part of Mr. Livingston Stone.

Among the principal fish thus introduced were 173 full-grown spawning black bass placed in Napa Creek; 16 full-grown wall-eyed perch (*Lucioperca*) placed in the Sacramento; 56 large Schuylkill cat-fish and 18 Mississippi cat-fish placed in the San Joaquin, near Stockton; 70 horned pout in Sacramento County; 12 eels in a lake near Sacramento; 305 small Eastern salmon in the Sacramento; and 4 full-grown black bass in Napa Creek.

Of salt-water fish, twenty-three tautog were deposited in the bay of San Francisco. The experiment with lobsters was not so successful; of 150 full-grown individuals,

only three arriving alive, which were also placed in the bay of San Francisco. About 1500 small salt-water eels were introduced in the same locality.

The Commissioners are satisfied that most of the species introduced have found congenial quarters, and will before long be heard from. Large numbers of young black bass have already been detected, as also some of the wall-eyed perch. The cat-fish have grown rapidly, the young of which are frequently seen. The horned pouts have increased so rapidly that nearly one thousand have been taken out and transferred. They were placed in lakes containing brush and dead trees, so that they could not be seined out. Of the fresh-water eels, one has been taken which had grown to be more than a foot in length.

A large number of whitefish eggs, furnished by the United States Fish Commission, were placed in Tulare Lake. Many eggs of the brook trout have also been transferred to the West. Nothing further has been done in the way of shad, although the Commissioners hope at another season to have a donation of young fish from the United States Fish Commission.

The Commissioners also refer to their co-operation with the United States on the M'Cloud River to multiply salmon in the Sacramento, $2000 having been contributed by Governor Stanford and Mr. Charles Crocker, by means of which it is expected that between two and three millions of young will be hatched and turned into the river. They think that the true interest of California is in increasing the numbers of her native fish as well as in introducing those from abroad, and they design to keep up their efforts to stock the Sacramento until an abundant supply shall always be insured.

They figure up 4,000,000 pounds of salmon as having been shipped from the Sacramento River between the 1st of November, 1874, and the 1st of August, 1875, not including what had been sent East and otherwise disposed of. Numerous important recommendations are brought forward by the Commissioners for the protection of the interests committed to them. Among others, they would have the laws for the protection of seals and sea-lions rescinded, as these animals destroy myriads of valuable fishes. They also urge that some restriction be made in regard to the capture of fish, especially in salt water, at improper times and by im-

proper methods, referring to the very great numbers of young fish destroyed wantonly and unnecessarily by the methods of fishing practiced by the Chinese.

CULTIVATION OF CARP IN CALIFORNIA.

Mr. J. A. Poppe, of Sonoma, California, calls the attention of the farmers of the United States to the subject of carp raising, in which he refers to his own experiences in the introduction of this fish into the country. In August, 1872, he arrived at Sonoma from Germany with five small carp, six inches long, all in very poor condition, one dying as it was placed in the water. In the following May he states that the fish had grown to be sixteen inches long, and had produced over three thousand young fish. He now has a very large stock, and all that he can send to market sell readily at one dollar per pound as an article of food, and he has no difficulty in disposing of all the living fish he is willing to spare at five dollars each. He remarks that when well fed the fish will grow one inch per week for the first two or three months, after which the growth in length is slower, but they increase in weight very rapidly.

CAPTURING EELS IN COCHIN CHINA.

An ingenious device is practiced in Cochin China for the capture of eels, which consists in cutting pieces of bamboo as thick as the arm into sections of about three or four feet in length, the divisions of the interior being broken out, with the exception of the one at the end, which forms the bottom of the snare. At the entrance is placed a slight grating of bamboo, and some bait, either of fish or earth-worms, is introduced into the interior. The bamboo is then laid at a slight depth in the mud, and the eels enter the hollow tube, in which they can scarcely move, and can not turn themselves, and are consequently taken captive. The bamboo is taken up every morning, and the eel, which holds on very firmly to the interior, is pulled out by means of a strong hook.—10 *B*, *June*, 1875, 290.

HATCHING WHITEFISH IN THE DETROIT RIVER.

The most gigantic enterprise in the way of the artificial multiplication of fish is that just now in progress on the De-

troit River by the Fish Commission of Michigan and that of Canada. It is well known that of all the fishes in the lakes the whitefish is the most important, and that upon its pursuit and capture is based a very important interest, which occupies a large number of men and an immense capital. This, however, is one of the species most readily affected by overfishing, localities which furnished an ample supply a few years ago being now almost entirely exhausted.

When the Fish Commission of Michigan was organized, a few years ago, its attention was early directed toward measures for restoring the whitefish to its original abundance, and more if possible, and various propositions were made, some of which looked toward special restrictions in regard to the mesh of nets, time of capture, etc. It was found, however, that all the enactments for this end would be very difficult of execution, and it was finally concluded to endeavor to increase the numbers of fish by artificial propagation to such an extent as to make it unnecessary to pass any restrictive laws. Partial efforts to this end have been previously made; but it was during 1875 that the work has been commenced on a really vigorous scale. At present the Commissioners have between 6,000,000 and 8,000,000 whitefish eggs in their new hatching establishment recently erected at Detroit, all reported to be in excellent condition, and likely to become vigorous fish, to be introduced into the waters of the lake during the coming year. Indeed, it is thought that by a new improvement, lately devised, it will be possible to hatch 30,000,000 the next year.

While this work is prosecuted satisfactorily by the Commissioners of Michigan, a similar enterprise is carried on by Mr. Samuel Wilmot on the Canadian shores opposite, who will probably hatch out 5,000,000 to 8,000,000, and who also expects to reach a minimum of 20,000,000 another season.

The importance of these enterprises can not be easily overestimated. It may be calculated that of each million of young fish placed in the waters, not less than 200,000 will attain a full maturity, and possibly a much larger percentage. The expense is a mere trifle in proportion to the results to be anticipated, and it will probably be found more economical to continue the work indefinitely than to trust to natural repro-

duction on the part of the fish themselves, or to protective measures, however stringent, for the future supply.

Another state equally interested in the object in view with Michigan and Canada is Ohio, and her Commissioners have also been doing what circumstances would permit them in the same direction. They have established four hatching-houses — one at Cleveland, in connection with the water-works; one at Castalia Springs, near Sandusky; one at Toledo, in connection with the water-works; and one on Kelly's Island, in Lake Erie. So much time was occupied in getting these stations ready that the Commissioners could not procure a large stock of eggs, but expect to do their full share another season. In this emergency the Michigan Commissioners generously presented them with 800,000 whitefish eggs, which have been distributed to the different establishments to be hatched out.

ONE CAUSE OF DEATH OF FISHES.

In inquiring into the cause of the death of many fishes, M. De la Blanchere considers this largely connected with the exhaustion caused during reproduction, and calls attention to well-known facts in the history of large trout under such circumstances.—19 *B*, *June* 10, 188.

RAPIDITY OF GROWTH IN CERTAIN FISHES.

Mr. Mitchell, in a communication to *Nature*, presents some remarkable facts in regard to the rapidity of growth of fishes. Referring to a species of carp, called by the natives *Katlah*, he states that this is a species that does not breed in fresh water, but that the natives are in the habit of introducing the fry into ponds, etc., where they thrive very satisfactorily. According to his account, a tank sixty-five feet long, fifty-eight feet broad, and thirteen feet deep was dug within the premises at Garden Reach, in May, 1875, and a number of the *Katlah* fry, from half an inch to an inch in length, were introduced about the end of July. On the 22d of September the tank was swept with nets to catch one or two fish of the pike species that had been accidentally introduced with the others. In the net were taken several dozens of the carp referred to, one of which weighed fourteen ounces, and was eleven inches in length. Others were only a few ounces

lighter. The food supplied to these fish consisted, in addition to the natural vegetation of the pond, of the refuse of rice and other substances thrown into the pond by the natives.—12 *A*, *December* 9, 107.

UTILIZATION OF WARMED WATERS IN FISH-CULTURE.

An important suggestion has been made in regard to the utilization of certain waters in the cultivation of fish, hitherto supposed to be unavailable. The author refers to certain ponds along the Rhine, connected with a variety of manufacturing establishments, which are intended to receive the water condensed by steam-engines. One of these ponds is about one hundred and twenty feet in length, with a depth at the sides of four feet, running down to sixteen feet in the centre, and is supplemented by the dike which runs around three sides of the manufacturing establishment. This dike in the aggregate is about 1600 feet long by twelve feet wide, and is six feet deep in the middle. The entire water area is about 24,000 feet, with a depth of six feet in the dike and sixteen feet in the centre of the pond. The dike and pond are simply excavated out of the earth, and are neither bricked nor cemented. They were simply made to carry away surplus condensed water, which runs into the pond at about 110° Fahr. The temperature of the pond just where the water runs in is about 90°, and in the coolest part 76° Fahr. Three hundred carp about five inches in length were introduced seven years ago, and now the young can be seen all the year round. Fish weighing four to five pounds are quite common, and one hundred pounds may easily be taken in an hour. Gold-fish also thrive excellently in the same water. It appears that the fish like best to be where the water is warmest, especially the younger ones. The locality referred to is near Bonn, on the Rhine.—2 *A*, *April* 5, 271.

SHAD IN THE MISSISSIPPI.

Ex-Governor Hebért, of Louisiana, announces in the papers of his state the receipt, in the month of March, 1876, of a fine specimen of the true shad, which was caught in a dip-net near his house. This, it may be presumed, is one of the many that have been planted in the Mississippi by the United States Fish Commission.

RENEWED ATTEMPT TO SEND SALMON EGGS TO NEW ZEALAND.

A very interesting experiment has lately been entered upon in Scotland, in the form of a renewal of the attempt to send salmon eggs to New Zealand for the purpose of stocking the waters of the antipodes. This was done principally under the direction of Mr. Frank Buckland, the well-known pisciculturist. For this purpose the salmon were taken in seines, and the ripe fish selected for the experiment. The process of impregnation consisted in dropping the milt from the male fish into a vessel containing a small quantity of water, and then stripping the eggs into the same receptacle, Mr. Buckland's experience teaching him that this is better than to place the eggs in the water first, where there is no milt. He also advises allowing the eggs to remain quietly in this condition for a considerable time before washing off.

The gathering of the eggs took place on the property of Mr. G. C. Home Drummond, of Blair-Drummond Castle, nearly opposite Inverardoch House. The eggs were then carried to Glasgow to be packed. They were placed in boxes holding a cubic foot each, stratified in layers between moss; and these were placed in a large ice-box, constructed expressly for the purpose, on board the ship. The ice-box measured thirteen feet in length by twelve in width, and eight in height. In packing, ice was first arranged along the bottom, two feet thick. Upon this was deposited a square, consisting of twenty-five salmon boxes, with four in addition at the corners. Upon these boxes was put a stratum of ice two feet thick, and upon this another layer of boxes of eggs, and ice again on the top of these. All around the sides of the ice-house slabs of ice two feet six inches thick were placed, so that the eggs were surrounded by blocks of ice, the minimum thickness being two feet. Ice was also packed in the interspaces between all the boxes, precautions being taken that they should not get loose. All around the ice-house was built another ice-box, leaving an interspace of eighteen inches. This was filled tight with sawdust, to keep the temperature as equal as possible. In addition to the salmon eggs, some thousands of eggs of trout were also forwarded.—2 *A, January* 16, 1875, 48.

SALMON IN THE ANTIPODES.

The actual existence of mature salmon at the antipodes, from the eggs transported thither, is not fully proved, although Mr. Youl is of the opinion that the evidence is clear as to the success in New Zealand, as he publishes in the London *Field* a paragraph from an Otago daily paper stating that a large salmon had been taken in one of the northern streams, its eyes having been picked out by a sea-gull. This was captured by parties familiar with the Scottish salmon, and who felt sure of its character. The fish weighed about forty pounds.

Mr. Youl also publishes a letter received by the Acclimatization Society of Otago, which had accompanying it a photograph of a salmon-trout taken in Otago Harbor, weighing ten pounds eight ounces, and measuring twenty-six inches in length. It is an interesting fact in this connection that in 1870 there were one hundred and forty eggs of salmon-trout brought from Tasmania, from which one hundred young fish were liberated in the beginning of 1871, from a stream about thirty miles north of Dunedin. Within the last eighteen months upward of a dozen sea-trout, weighing from two to five pounds, have been taken, in addition to the one first referred to, so that we have here at least fourteen fish out of one hundred already captured, with a strong probability that a good many more escaped the perils of infancy, and attained maturity. This percentage of fourteen in a hundred is much larger than fish-culturists have dared to claim as the result of their efforts, and if it be any thing like an average, it furnishes a great encouragement to the efforts now in progress in America and elsewhere to introduce and multiply useful food fishes.—19 *A*, *February* 19, 196.

SALMON EGGS IN SOUTH AFRICA.

Among the efforts to acclimatize the salmonidæ in the southern hemisphere may be mentioned the transmission of eggs of the trout to South Africa. Mr. Campbell Jobson, about Christmas, 1875, obtained from Frank Buckland some eggs for the government of the Cape Colony, and succeeded in transporting a large proportion in good condition to Cape Town. Here they were placed in charge of Dr. Hidding, who

had provided himself with the necessary apparatus; but, though a number of the fish were hatched, only one survived. It was thought that a more extended time for preparation would have given a more satisfactory result.—2 *A*, *June* 17, 440.

CAPTURE OF SALMON IN THE CONNECTICUT RIVER.

We are happy to announce the capture in a gill-net at Middle Haddam, in the Connecticut River, on the 24th of June last, of a superb salmon weighing eighteen and a half pounds. It is well known that the Connecticut, up to the early portion of the present century, abounded in salmon—to such an extent, indeed, that the usual plea was made by paupers and apprentices that they should not be obliged to eat them more than two or three times in a week. For many years, however, the fish has been entirely exterminated there, and there was no hope for a restoration except as the result of the action of the State Fish Commissioners in introducing the young into various parts of the stream. Judging from the size, it is probable that the fish now taken is one of the 30,000 fry placed in Williams River, in Vermont, in 1870, and it is to be hoped that more of this crop, as well as of the succeeding, will make their appearance. Several millions of young fish have been placed in the Connecticut, most of which, however, will not be due for a year or two. The specimen in question was sold for ten dollars in the Hartford market.

ARTIFICIAL CULTURE OF PEARL-OYSTERS.

At a recent meeting of the Society of Acclimatization of Paris, a medal of the first class was awarded to Lieutenant Mariot for having established at the island of Arutna, one of the Paumotou islands of the Oceanic group, artificial inclosures for the cultivation of pearl-oysters, the result of the experiments so far made promising that the enterprise would be successful.—10 *B*, *May*, 1876.

REPRODUCTION OF THE OYSTER.

Gerbe, who has given considerable attention to such subjects, informs us that oysters are capable of reproduction

during their first year of growth, much before they have attained a marketable size. He has even seen oysters of less than an inch in diameter with the sexual conditions mature. It would therefore appear that the multiplication of this important bivalve does not require the presence, in a park, of full-grown oysters, since those of a much smaller size have been proved to answer the purpose.—3 *B*, *March* 2, 307.

FATTENING OF OYSTERS.

Professor Fraser, in a communication to the Academy of Natural Sciences, in speaking on the general subject of Dialysis, suggested its application to the fattening of oysters, remarking that oysters brought to the large markets are generally immersed for a short time in fresher water than that from which they were taken, resulting in an increase of size or plumpness. This, however, only lasts for a few days. At the end of this time the oysters become lean again, having lost the plump appearance. Dr. Fraser remarks that, although sometimes corn meal or other substances are placed upon the oysters during this operation, it can have no material effect in increasing the amount of the flesh, but that the increase in size is due entirely to the absorption of moisture. The tissues of oysters when first taken are saturated with the ocean brine, and when removed to fresh water, or that which is less salt, the external liquid passes inward more rapidly than the more saline and denser elements within can escape; the effect being simply to cause the oyster to swell, with no increase of its virtues. When the water in which the oyster is immersed is too fresh it loses its flavor. Professor Fraser suggests that by immersing the oysters for some days in concentrated brine, and then removing them to ocean water, the plumpness would be gained without the sacrifice of the saltness which is so agreeable to the epicure. A simple method of ascertaining whether the oysters increase in flesh or not would be to take one hundred or more from a given locality on the sea-coast, and, drying them at 220° Fahrenheit, ascertain their average weight; after which repeat the process for the same number of like oysters after being gathered and treated in the usual manner.—2 *D*, 442.

K. DOMESTIC AND HOUSEHOLD ECONOMY.

THE CONSTRUCTION OF WINDING STAIRCASES.

In Major Elliott's Report on European Lighthouses, he notes that in several cases the stairs are circular, and apparently self-supporting, one end only being built into the wall, as in the Treasury at Washington. This method of stair-building is, he observes, universal in Europe, both in private and public buildings. The most recent lighthouse towers of the American system are constructed with conical interior walls and iron staircases winding around the interior of the cone. European towers are generally constructed with an exterior conical, and an interior cylindrical wall, leaving an unnecessarily large unused space between the two. The amount of masonry in the American system is the same as in the European, and is better calculated to resist the overturning effect of the severest gales.—*Elliott's European Lighthouse System*, p. 25.

SELF-CLOSING HINGE FOR STORM-DOORS, DOUBLE DOORS, ETC.

A very ingenious self-acting hinge for storm-doors, double doors, etc., opening in one or both directions, has been devised by Koch, of Berlin. It is said to allow the door to move easily and noiselessly, and also to be fixed at an angle of a little more than ninety degrees, if desired, without any fastening. A full description, however, can only be given with the aid of a figure. The door moves on a pivot at the top and bottom, the rear end at the bottom resting in a shoe, to which it is firmly screwed, and which has the pivot attached to it beneath, and also a small wheel a little in front of the pivot. As the door is opened this small wheel moves upon an arm of a lever, the other arm of which is in contact with the end of an almost circular horizontal spring, which carries the door back to its normal position, as soon as it is released, the power being greatest just when the door is released, and diminishing until it is completely closed. The spring, lever, etc., are inclosed in a cast-iron box, covered with a brass plate, screwed to it, countersunk to the level of the floor. The upper socket, set in the casing of the door,

is attached to a plate, which has a slit and set screw, so that it can be moved forward or backward slightly, and thus be adjusted to any inaccuracies in hanging the door. The upper pivot is let into the top of the door and rests upon one end of a lever, also let into the top of the door, and is forced up into the socket by a screw acting on the other end of the lever, nearer the front of the door, thus rendering it easy to hang or remove.—5 *C*, XLVI., 366.

MYSTERIOUS CLOCKS.

Robert, of Paris, has succeeded in carrying out practically an old suggestion for the construction of clocks apparently without works, by employing aluminium for the light parts, and platinum for a movable weight. The clocks, as made by him, seem to consist simply of a glass face, supplied with two hands, to which counterpoised weights are attached. These latter, however, contain diminutive works, which vary the position of a piece of platinum in such a way that its weight, in connection with that of the hands themselves, causes them to turn.—6 *C*, *June* 3, 1875, 216.

PREVENTION OF THE CRACKING OFF OF GLUE.

The cracking of glue, which frequently occurs when glued objects become very dry or are subjected to the heat of a stove, it is said, may be prevented by the addition of chloride of calcium to the glue, which prevents its drying so completely as to become brittle. Glue thus treated will adhere to glass, metals, etc., and can be employed for affixing labels to bottles.—5 *C*, XXXVIII., 304.

NEW LIFE-SAVING DEVICE.

The Paris Maritime Exhibition afforded the opportunity for the experimental demonstration of the great value of the "Gay Safety Mattress," an indorsement in which all accounts agree. The device, which is both a mattress and, in case of necessity, a life-preserver, is formed of two rows of blocks made of cork-cuttings, lightly compressed by machinery within a water-proof case, and the whole covered with canvas. It forms ordinarily a mattress, which is intended to be placed in every cot or berth, and makes a bed which is said to be very elastic and easy to lie upon. Its weight is about six

and a half pounds, and it is constructed in such a manner that it can be quickly put about the person, forming then a double belt, attached in such a way that it can not possibly be displaced. The whole process of rising from the mattress, attaching it to the person, and entering the water was performed at the Exhibition within three quarters of a minute. The limbs are not confined, nor the motions of swimming interfered with. It places within reach of every passenger an efficient and reliable life-preserver in any sudden emergency, and appears to be the most sensible and practical device of this kind as yet invented.

ELECTRICAL ILLUMINATION OF FACTORIES.

In spite of the recent improvements in magneto-electric machines, especially that of Gramme, electrical illumination in factories has not displaced that by oil or gas to any extent. The Gramme machine has, however, been introduced, with satisfactory results, into an establishment at Mülhausen. The room illuminated is 196 feet by 98 feet. Four lamps, on Serrin's plan, properly distributed, are employed, each run by a separate magneto-electric machine requiring about two-thirds horse-power to work it. The carbon points need changing every three hours. The cost for the four lamps per hour is about twenty cents. During two months of use no diminution of intensity has been noticed, and the illumination afforded has been steady and superior in brilliancy to that from any other source. The magneto-electric machines cost about $300 apiece, or the four arranged, complete, about $1600. Laboulaye gives the following table of the comparative cost of this and other methods of illumination:

Source of light.	Consumption per hour for 1-stearin candle-light.	Cost per hour for a 700-stearin candle-light.
Electricity, by magneto-electric machine.		0.10 to 0.20 francs
Electricity, by galvanic battery..........		3.00 to 5.00 "
Coal-gas..............................	15 litres	3.20 "
Light petroleum.........................	4.52 grammes	3.85 "
Rape-seed oil...........................	5.18 "	6.10 "
Tallow candles..........................	10.55 "	12.60 "
Stearin candles.........................	10.40 "	26.20 "
Wax candles.............................	8.26 "	32.40 "

Efforts to distribute the current from a single machine to several lamps have not proved practically successful, by rea-

son of the great increase in the cost of illumination, so that Gramme has been led to construct small machines of fifty candle-power. While these operate very well, the light, however, is not perfectly steady, and the machines found best adapted to practical purposes are those that yield a one hundred candle-light.—6 *C, June* 3, 1875, 215.

A NEW INCANDESCENT LIGHT.

Hannecker, taking advantage of the properties of incandescence, has obtained a lamp of extraordinary brilliancy by directing the flame of a spirit-lamp of special construction and fed by a current of oxygen against a cylinder composed of silicate of lime, magnesia, and olivine, which latter is a natural silicate of magnesia. The cylinder composed of these earths is compressed by hydraulic pressure, in a manner not very different from the method employed for forming the cylinders used in the Drummond light.—3 *B*, XXXV., 247.

AUTOMATIC HYDRAULIC BLOWER FOR GAS-MACHINES.

A recent invention designed to substitute the meter wheel and weight (or coiled spring), water-wheel, and other devices for driving air gas-machines, consists of the well-known mechanical device known as the tromb, or water air-pump, in connection with an automatic cut-off valve operated by the rise and fall of the gasometer dome. The whole machine is self-contained, and is completely automatic in its action.

COMBINED STREET-LAMP AND FIRE-HYDRANT.

An invention of this description, which is now attracting attention from the heads of fire-departments, is designed to diminish the number of obstructions to the highway, and to afford light in finding the hydrants and operating the engine. The valve is of peculiar construction, operating with a quarter turn of the spanner, and affording unimpeded water-way.

NEW SAFETY-LANTERN.

In Paris, night-watchers of factories and warehouses containing highly combustible material are supplied, for safety, with a peculiar lantern. A piece of phosphorus about the size of a pea is introduced into a glass flask, which is then one third filled with boiling olive-oil and closed air-tight with

a cork. When light is desired the cork is simply removed for an instant to admit the air, and a clear light is emitted from the empty space in the flask. The intensity of the light when it diminishes may be renewed by admitting air again. A lantern thus prepared, it is said, may be used continuously for about six months without the least trouble.—15 *C*, XXIII., 368.

THE CHANDOR LIGHT.

At a recent gathering in Edinburgh, Professor Archer drew attention to a new invention—the Chandor light. The apparatus is, in outward appearance, a small tube three or four inches long, having at one end a revolving button, which turns a screw, and at the other a minute angular point of metal, which also revolves, passing over a little orifice in the closed head of the tube. A continuous tube, formed of a delicate strip of solidified collodion, with a ridge of hardened phosphorus on one of its sides, is slipped into the tube, and, once in position, can be moved upward by the screw. By the same action which presses the upper end of the fuse against the opening of the top, the metal point is turned against the phosphorus, and a small portion of the collodion is thereupon ignited. When the apparatus is affixed to a gas-burner, only a very transient flash is needed for the purpose of ignition, and not more than a seventieth part of the collodion fuse is consumed in the operation. When, however, the wick of a lamp has to be lighted by the same means, a larger proportion of the fuse, the thirty-second part in fact, is burned. The apparatus is either portable or adapted to the uses indicated. If a lamp goes out, it can be instantly relighted by a turn of the screw, instead of by opening the case, removing the chimney, and striking a lucifer match, thus affording a great advantage in cases where quantities of combustible material are lying about.—*The Builder*, *Feb.* 13, 1875, 149.

LAMP FOR BURNING NITRIC OXIDE GAS.

The brilliancy of the light produced by the combustion of nitric oxide gas, after mixture with a few drops of sulphide of carbon, has been known for some time, and its application to photographic purposes suggested; but it is not until recently that Messrs. Delachanal & Mermet have constructed an apparatus by which it can be made practically available.

They use a lamp made of a pint bottle, having two openings through the cork, and filled with fragments of some porous substance, as sponge, coke, or pumice, for the purpose of imbibing the sulphide of carbon. A tube, reaching within one fourth of an inch of the bottom, passes through one opening in the cork, and a larger one through the other opening. This is about eight inches long, and may be of glass or metal, and is closely packed around with iron-scale. The object, like that of the gauze in the safety-lamp, is to prevent the return of the flame into the bottle, and its consequent explosion. The nitric oxide gas is passed into the bottle through the first-mentioned tube, and the gaseous mixture is conducted by a rubber tube to a kind of Bunsen burner, the air-holes of which are closed, and which is furnished with a small conical valve to regulate the flow of gas. This burner is also filled with iron-scale. The nitric oxide gas is produced in the cold by Sainte-Claire Deville's method, by the action of a mixture of nitric and sulphuric acids upon metallic iron. With an apparatus of quite moderate dimensions a dazzling flame, not less than ten inches in height, can be obtained, abundantly sufficient for the purposes of photographic work. It has been estimated that the photographic power of the lamp is superior to that of magnesium, is twice as great as that of the oxyhydrogen light, and three times as great as that of the electric light. Furthermore, the flame is absolutely steady, and there is no danger of its sudden extinction, as with magnesium; and the eye can sustain its brilliance without being affected. Its cost is much less than that of either of the other lights.—1 *D*, *December*, 1874, 381.

GLYCERINE FOR ILLUMINATION AND HEATING.

Godeffroy, of Vienna, found that chemically pure glycerine (sp. gr. 1.2609), when heated to 302°, burned quietly with a blue, non-luminous flame, without the least odor and without leaving any residue, and also that glycerine of low specific gravity, if not too dilute, may be burned by means of a wick or cotton immersed in it, in an open porcelain capsule. Schering has recently communicated the fact that it can be burned in any lamp in which the flame is immediately above the level of the liquid (such as the Berzelius lamp), its thick consistency preventing its giving a constant flame with a higher

wick. Since its flame is but slightly colored, like that of alcohol, and since it is a much better solvent for salts, he found it preferable for the production of different colored flames; and he suggests the importance of further experiments upon the adaptation of it to illuminating purposes by mixing it with other substances rich in carbon, and also upon its heating power. Its cheapness and freedom from danger, owing to its comparative non-volatility, would render its use for the above purposes desirable.—6 *C*, 1875, 38.

ILLUMINATING-GAS FROM BONES.

As an illustration of an ingenious utilization of a waste product, the River Platte Meat Preserving Company's works in South America afford an example. Here the bones of the cattle, the flesh of which goes to fill the pots of "fleisch extract," are made to yield the illuminating-gas by which the company's factory is lighted. The works are very extensive, and some two hundred burners are supplied from these novel gas-works.—3 *A*, VI., 323.

GAS FROM CORK-WASTE.

At Bordeaux some experiments in manufacturing illuminating-gas from cork are reported to have proved quite successful. The town of Nérac, in the neighborhood, is to be lighted by it. It is obtained by distilling cork-waste, cuttings, etc., in a closed vessel, and the gas is said to be much whiter and more brilliant, as well as of heavier gravity, and cheaper than that from coal.—3 *A*, VI., 426.

BURNING-GAS FROM WOOD AND PETROLEUM.

The process of Messrs. Date & Eichbaum for making illuminating-gas is sufficiently novel and interesting to warrant the following description of the system lately introduced into the town of Ingersoll, Ontario. The retort benches (threes) here in use have some differences from the arrangement usual for coal-gas. The upper retort is provided with an inner or interior retort of cast iron, into which a regulated supply of crude petroleum is fed by an air-compressing device. The operator having thus perfect control of the amount of oil introduced, a gas of any desired candle-power can be made. The charging of the retorts and the opera-

tions involved in the process are as follows: One of the lower retorts is charged with one hundred and fifty pounds of ordinary cord-wood, and as soon as gas begins to be evolved—which is almost instantly—by means of suitably arranged pipes and valves, the wood-gas is thrown into the upper retort, in which it comes in contact with the heavy vapors evolved from the petroleum. The two gases thus commingled are then passed over a lengthened heated surface, the resultant product being a fixed or permanent gas of any desired illuminating power, leaving little or no residuum. The charcoal resulting from the process is declared to more than pay for the wood employed.—17 *D*, XX., 32.

SULPHUR IN COAL-GAS.

To estimate rapidly the amount of this impurity existing in illuminating-gas, Mr. Vernon Harcourt proposes to pass the gas through a flask filled with small pebbles, kept at a low red-heat, by which the sulphur present as bisulphide of carbon is decomposed into sulphuretted hydrogen; a known volume of the gas is then passed through a solution containing a lead salt of given strength, and the depth of coloration produced is compared with a standard set of colors, by which the percentage of sulphur is obtained.—*Proceedings British Association*, 1875.

ILLUMINATING-GAS FROM NIGHT-SOIL AND DEAD ANIMALS.

As the conversion of refuse animal matter into illuminants has often been suggested as a practical method of solving a troublesome sanitary problem, it is of interest to record the experience of Professor Troschel, director of the gas-works at Breslau, in Prussia, with an improved process of this nature lately invented by A. Sinderman. The Sinderman system, having been favorably reported upon by a committee selected by the city authorities, was introduced upon a working scale, and subjected to a careful investigation as to the quality of gas produced and its cost, and with the following results: The quantity of gas produced from a given weight of material was found to be considerably less than from the same weight of coal, so much so that, for the production of equal quantities, the new works would demand about twice the capacity of the old system with coal. The expense of

the new process was found to be, contrary to all expectation, about double that of the old system. The removal and condensation of the enormous percentage of water contained in the animal refuse was found to be a source of great practical inconvenience, involving the use of an enormous cooling apparatus. One of the chief economical features of the coal system, namely, the production of coke, which not only suffices to run the works, but to return an income from the sale of the surplus, is wanting in the new process, for the operation of which the fuel must be bought. But perhaps the gravest objection to the new system lies in the fact that the refuse materials employed contain large quantities of nitrogen, sulphur, and phosphorus, and their compounds enter the gas produced as ammonia, sulphuretted hydrogen, and phosphuretted hydrogen in such unusual quantities as compared with the old system that their removal, which is absolutely necessary, demands mechanical arrangements of so complex a character as to become quite impracticable of successful operation upon a large scale. For the reasons specified, the process has doubtless been abandoned. The results of this trial, though unfavorable, are both interesting and valuable, as demonstrating the existence of grave and perhaps insuperable difficulties in the way of the utilization of such refuse matters as illuminants. There is still great room for improvements in the methods for their conversion into fertilizers.

WALKING-CANE CONTAINING A CANDLE.

A very simple walking-cane, with a candle inclosed, which might be convenient for use in dark passages, or even for reading in railroad-cars, has been introduced by a German firm. The top portion consists of a hollow cylinder screwed on, and containing a spring to press upward, as fast as consumed, a candle placed in it. It is closed by a screw cap, which forms a convenient top.—12 *C*, X., 1875, 2.

A REFLECTING-PLATE FOR OPEN GRATE FIRES.

A recent novelty among adjuncts to stoves and fire-places consists in the employment of a bright nickel-plated sheet of metal, suspended over the fire, and adjusted in proper position by a crank, the rod of which passes through the side of the stove or fire-place. While the fire is being kindled, the

plate is turned toward the front to protect it from being smoked, but when the fire is fairly burning, the plate is turned back at an angle of forty-five degrees, as indicated by the wheel on the side of the stove. The result is described about as follows: The reflection from the bright metallic surface produces the effect of a double fire, and adds greatly to its cheerfulness. In addition to this, it is claimed that the large amount of heat thus reflected by the plate is, to a great extent, a clear gain, and that the effect of its employment is readily perceived in increased warmth at quite a distance from its source. Furthermore, it is claimed that the rush of air usually passing up the chimney of an open stove or grate, and which makes this excellent form of heating apparatus so expensive in rapid consumption of fuel, is checked and thrown down on the fuel, producing surface combustion, while the draught at the base may be shut off, giving a clear, bright fire, without wasteful consumption of coal.—*Iron Age, September* 30.

METHOD OF COOLING THE AIR.

MM. Nezereaux and Garlandal have lately devised a process of cooling and at the same time purifying the air introduced into dwellings for purposes of ventilation. It consists of a fan caused to revolve rapidly, by means of which the air is forced into a closed box, and made to pass through a horizontal diaphragm with holes, over which a very thin layer of water is continually flowing. The air, as it passes through this thin film of water from below, is deprived of its organic particles, which remain in solution in the water, which is continually dripping down into the lower chamber and drawn off, the air itself passing up and out through a pipe in any desired direction.—13 *B, Dec.* 18, 34.

IMPROVEMENT IN FIRE-PLACES.

Forestier describes an improvement in the ordinary fire-place, in which by contracting the smoke-flue for some distance above the fire-place, and by introducing side flues for the admission of fresh air, he is, he states, able to effect a very material economy in the consumption of coal; the fire-place as built by him, with an open basket grate, is superior to any of those described by Morian, Peclet, Grouvelle, and Clement. He finds that ordinary chimneys, producing the

same result as attained in his own, consume four times the quantity of fuel; and the comparison with even the most improved chimneys is always decidedly in his favor.—*Memoirs Academy of Sciences, Toulouse*, 1875, 233.

CHEAP SOAP FOR ORDINARY ARTICLES AND WOOLEN FACTORIES.

Mayr recommends the following process for preparing a very cheap soap. First procure from a soap-boiler the spent lye or salt lye, either in a fluid or gelatinized condition, and preserve it in well-covered vessels until required. Prepare a soda lye of 22° Baumé, by heating in a boiler 100 pounds of calcined soda in about 52 gallons of water until it is dissolved. Add to this gradually 60 pounds of fresh, unslaked lime, stir the mixture well, and transfer the whole of it to a tub of sufficient size, and allow it to stand for about 12 hours, that the lime may settle. Then carefully dip out the lye from the lime into the kettle again, and boil until it indicates 22° Baumé. After cooling, transfer to a suitable vessel, and cover tightly. Then prepare a potash lye of 10° Baumé, by stirring potash into hot water, until the required strength is reached. As an experiment, boil 25 pounds of cocoa-oil with 30 pounds of potash lye of 10° Baumé, and add gradually, when not boiling too vigorously, 30 to 40 pounds of soda lye of 22° Baumé. After the combination of the oil and lye, and the mass has assumed the appearance of a brown glue, and is thready, add, with vigorous stirring, 159 pounds of spent lye of not over 16° Baumé, but diluted to this strength, if necessary, with lime-water. Boil the mass for half an hour, and allow the fire to die down. It will appear as fluid as water, and very unlike soap, but a sample, if allowed to cool perfectly on a board, or in a porcelain dish, will harden. The principal point at this stage is to transfer the mass to a tub, and allow it to cool, and on the following day to transfer it again to the boiler without the addition of any liquid, and after boiling it for an hour, samples will yield elastic threads indicative of increasing consistency. Then add common salt gradually, until a cooled sample feels dry upon the hand. Allow the fire to slacken, and ladle the mass into forms, which can be taken apart when the soap becomes hard. The advantage of this proc-

ess is increased by repeated warming and cooling of the mass, as the proper consistency is thus hastened, and the quantity of soap increased. Cocoa-soap shavings may also be employed according to the fat they contain. If the spent lye is old, and has been exposed to the air, dilute 12 pounds of potash lye, of 22° Baumé, with lime-water to 10°, and boil it with the 25 pounds of cocoa-oil. The addition of a few pounds of crude palm-oil will impart to this soap a color similar to that of tallow soap.—26 *C*, II., 1876, 14.

CLOTH OF FEATHERS FOR LADIES' CLOAKS, ETC.

The following are the essential features of a process, recently patented, for the manufacture of cloth, suitable for ladies' cloaks and all kinds of garments, from feathers, principally of water-fowls. As the down only can be employed, the material is assorted, according to its specific gravity, by a fanning-machine. Then, after being soaked in water containing Marseilles soap, and pressed out in a square box by aid of a screw, and separated again, and partially dried by means of the fan, it is oiled, and passed three times through the fanning-machine. A fleece of wool, formed on the usual carding-machine, is then covered loosely with four times its weight of the feathers, and these by another layer of wool. The rove is then formed in the usual way, provision being made to prevent two threads from uniting. In spinning a large hand machine is employed, instead of a self-actor. The weaving is accomplished in the usual way, except that, as a rule, warp of combed-wool yarn is preferred, although, according to the material, it may be of carded yarn, or even of carded yarn and feathers. The cloth is oiled, and fulled as usual, with care to dry after fulling. In dyeing a very large vat must be used, that the whole breadth of the piece may be immersed at a time. It is finally beaten and brushed to remove any feathers not fully incorporated with the wool, and a gloss is imparted to it by steaming.—23 *C*, *Jan.* 1, 1876, 4.

COOKING MEAT BY COLD.

The generally accepted theory of the cooking of meat relates to the application of heat; but quite recently Dr. Sawiczevosky has called attention to the fact that almost precisely the same chemical and physical changes can be ac-

complished by the exposure of animal flesh to extreme cold. Indeed, the sensation experienced by touching freezing mercury is very much that of a severe burn. The experimenter referred to proposes to apply his method to the preservation of meats, first by subjecting them to a temperature of 33° Fahr. below zero, and then sealing them up hermetically in tin vessels. Animal substances, kept for a long time in these boxes, on examination proved to be extremely palatable, and, being partially cooked, required but a little additional heat to prepare them for the table.

The German government has lately been prosecuting investigations into this process as a means of preparing military and naval supplies, a large quantity suitably sealed being placed on board some vessels undertaking a long voyage, with a view of determining more definitely its availability for the purpose referred to. An establishment in Hungary is now engaged in the preparation of meats by this method on an extensive scale.—12 *B*, *April* 1, 1876, 286.

ANTISEPTIC ACTION OF SALICYLIC ACID.

In further continuation of his experimental trials of this substance, Dr. C. Neubauer affirms that salicylic acid will be of great value in the preservation of wines, but that it is adapted rather to prevent than to correct or cure morbid changes that have taken place therein.—4 *B*, *Sept.*, 1876.

PRODUCTION OF MADEIRA WINE.

It is well known that for some years past Madeira wine has been almost unknown in the trade, on account of the extinction of the crop of the island consequent upon a long series of bad vintages. The old vineyards were rooted up, and new ones planted; but of course a long time would have to elapse before any great yield could be expected, and those having in their possession genuine Madeira held it as a great prize. The least period of production extended from 1853 to 1857; and from 1860 to 1862 but 500 pipes were produced. At present the production has risen to an average of 10,000 or 12,000 pipes, which is about one third that of former years. It is not thought, however, that the quantity will ever much exceed this, since a great deal of the island which formerly was planted with vineyards is now used for corn

and other crops, which are said to pay the proprietors better than wine.—17 *A*, XXI., 117.

CLEANSING SILVER-WARE, ETC., WITH POTATO-WATER.

Silver and plated articles should be placed about ten minutes in the hot water in which potatoes have been boiled (with salt), and then be rubbed with a woolen rag, and rinsed in pure water, when the articles will not only be free from tarnish, but perfectly bright. Potato-water that has become sour by standing several days answers still better, and is also excellent for cleaning articles of steel and glass water-bottles.—5 *C*, *March*, IV., 32.

SUBSTITUTE FOR PERSIAN INSECT-POWDER.

The wild rosemary (*Ledum palustre*) has been suggested as a substitute for Persian insect-powder. When dried as well as fresh it is destructive to lice, bugs, fleas, moths, etc. The tincture prepared from it is also a remedy for the bites of gnats, and insects generally; not only relieving the itching in a short time, but also the pain when applied to a wound. The tincture repels gnats when mixed with glycerine and rubbed upon the skin. It seems to deserve notice on account of these properties, and its possible substitution for the more expensive and frequently adulterated Persian insect-powder. It is most effective when fresh and in bloom, and should be gathered in the latter condition.—5 *C*, 72.

DETECTION OF OLEOMARGARINE IN BUTTER.

According to Mr. Horsley, it is not difficult to determine by chemical tests the presence of oleomargarine, or artificial butter, as an adulteration in genuine butter. He remarks that fresh butter is completely soluble in methylated ether of specific gravity 0.730 at a temperature of 65°. If methylated alcohol, 63° above proof, be added to this, and well shaken, all the lard, beef, mutton, or tallow fats that may have been mingled with the butter will be precipitated. Care, however, is to be taken not to mistake the crystallization of butter out of the ethereal solution, at a lower temperature than 65°, for the fats precipitated by the alcohol. The butter, besides, being so much lighter, occupies the upper layer, is different in character, and is easily remelted by the

application of the warm hand for a minute or two.—17 *A*, VI., 106.

PRESERVATIVE ACTION OF SALICYLIC ACID.

Messrs. Menetti and Musa find that salicylic acid is very serviceable in the preservation of milk when introduced in the proportion of one part in ten thousand, especially at a temperature from 55° to 60° Fahr., as it will retard coagulation for several days. It may also be used for moistening cloths in which butter is packed for shipment for distant markets. It also answers a good purpose in the preservation of cream, but is useless when applied to cheese. They think, however, that in view of the greater cheapness of boracic acid, the latter substance is preferable.—4 *B*, *Aug.*, 1876, 771.

SOLIDIFIED MILK.

A series of tests of the excellence of the Hooker process of condensing milk was lately made before several of the English technical societies. There was exhibited at the rooms of one of these—the London Society of Arts—a mass of condensed milk weighing about one hundred-weight, which had been exposed to the action of the atmosphere for four years and three months, with so little deterioration of quality that it afforded within a few minutes, by churning, an excellent quality of butter.

ACTION OF COLD ON MILK.

Tisserand has lately been prosecuting some investigations in regard to the action of cold upon milk and its derivatives, as compared with the influence of heat, and has already deduced some important conclusions that will be of service to those engaged in the manufacture of butter and cheese. He finds that on submitting the milk of a cow, immediately after being drawn, to different temperatures between 32° Fahr. and 86° Centigrade, and keeping it from twenty-four to thirty-six hours at the same temperature, the following results appeared: First, the separation of the cream is rapid in proportion as the temperature to which the milk is exposed approaches to 32°; second, the volume of the cream obtained is larger when the milk has been submitted to a greater degree of

cold; third, the yield in butter is also more considerable when the milk has been exposed to a low temperature; fourth, the skimmed milk, butter, and cheese are improved in quality in the latter case.

The explanation of these phenomena Tisserand thinks is closely connected with the observations of Pasteur in regard to the origin of ferments, and the alterations which are produced in the media into which they are introduced. He suggests that this decided cooling prevents the evolution of the living organisms composing the ferment, and the power of producing alterations by their action, the influence of cold in this respect being quite similar to that which occurs in the manufacture of the Vienna beer by ice, which is so remarkable in its qualities.

There is still, however, a wide field of research open, which Tisserand thinks should be investigated. However this may be, he states that the preceding facts show how erroneous are the views which have prevailed in France on the subject of the manufacture of butter, namely, that the cream must be kept at a temperature of 55° to 56°, and not go below this. On the contrary, he insists that the two cardinal requisites for the proper manufacture, especially of butter, are perfect cleanliness of the vessels used, etc., and the employment of a low degree of temperature. There has been a tendency in France within the last few years toward the use of lower temperatures than were formerly considered necessary; but even these, according to Tisserand, are not sufficiently low.—1 *B*, *March* 5, 1876, 349.

COOKING LEGUMINOUS VEGETABLES.

The lime salts in well-water frequently prevent the thorough cooking of leguminous vegetables, especially of pease and lentils, but the employment of rain or spring water does not in all cases produce satisfactory results. By soaking them overnight in soft water, success is more certain, as they not only swell up, but part with an unpleasant acrid substance. For this reason the water in which they have been soaked should be poured off, and the vegetables washed and cooked with fresh water. With old vegetables success is more certain if we add to each one or two quarts of soft water in which they are to be soaked half a teaspoonful of

baking-soda. They will not only be rendered softer in this way, but also more palatable and digestible. The addition of the soda to the water in which they are boiled does not answer the purpose as well, and in such case care must be taken not to add too much soda—at most only three to four times as much as will lie on the point of a knife to the quart of water.—10 *C, June* 1, 1876, 92.

GLYCERINE-GELATIN FOR PROTECTING PRESERVED FRUIT.

A composition of glycerine and gelatin, similar to that employed for printers' rollers, but of purer materials, is recommended for protecting preserved fruit, etc., from the action of the air and fermenting agencies. A thin layer of the fused mixture is simply poured upon the fruit and allowed to harden. It can be readily removed, and may be used again for the same purpose by melting it on a water bath.—13 *C, May* 1, 1875, 583.

SUBSTITUTE FOR EXTRACT OF MEAT AND PRESERVED MEAT.

Ungerer considers all the processes proposed for the extraction of meat or its preservation as liable to the objection of loss of a portion of the nutriment, or of complexity and expensiveness. He suggests, therefore, the following plan for utilizing the supply of meat in the less densely inhabited portions of the earth, by the conversion of it at little expense into a preparation which contains all the nutritious qualities of the fresh meat, and satisfies all requirements as to keeping. He dries the chopped meat at a temperature but little above 212°, under such conditions that all the water is expelled in less than half an hour, and the residue can then be converted into a fine yellowish powder, which, for convenience in packing, may be pressed into cakes or blocks. —14 *C*, CCXX., 382.

ICE-CELLARS ON BRAINARD'S PLAN.

The chief object in the plan for ice-cellars patented by Brainard is to prevent the deposition of the moisture in the air upon the walls, which injures them, and which also, by running down upon it, occasions a waste of the ice. The improvement is accomplished by placing a corrugated tin covering above the supply of ice, upon which all the moist-

ure of the air deposits, and is then carried off by a suitable wooden gutter; the air of the cellar being thus always kept dry.—5 *C*, IV., 1875, 31.

REPAIRING LEAKY CELLAR WALLS.

The repairing of leaky cellar walls should never be delayed, since the crevices are continually widened by the water soaking through. Cement, tar, and water-glass are the best materials for the purpose, but the last two can only be used at a time when the cellar is dry, as in winter, perhaps even in September, or after drying and airing it in winter by artificial means. When nearly dry the leaky portions of the wall can readily be recognized, and should be marked with charcoal. Holes and cracks should first be filled with hydraulic cement. The marked places, when dry, should be coated three to four times with a solution of one volume of commercial water-glass in two of water, and finally, after becoming perfectly dry, with a solution of one volume of water-glass in one half a volume of water. Instead of the solutions of water-glass, tar, kept quite liquid by heating, may be laid on a number of times. If cement is to be employed, the marked portions of the wall should be cut out wedge-shaped, and carefully filled with a cement rather thickly made up with one third sand. If the cellar can not be dried, the moist places should be cut out somewhat deeper (four to six inches), and filled with cement, by placing a tube of any material, about as thick as a finger, in the middle, and packing the cement in tightly around it; and, if necessary, holding it in place with a board until it hardens, while the water escapes through the tube without exerting any pressure upon it. After twenty to thirty days the opening may be plugged up.—8 *C*, XII., 204.

EXPLOSIONS IN FLOUR-MILLS.

An explosion which took place, in 1872, in a flour-mill in Glasgow, led to an examination of the subject by Dr. S. McAdam, who, having discovered that similar ones had taken place in Scottish flour-mills on previous occasions, has presented to the Royal Scottish Society of Arts, a thorough analysis of the causes leading to these explosions. Most of the improved modern mills employ what is called an exhaust

box, into which is drawn all the fine and light flour dust, thereby keeping the general air of the mill more free from the flour dust floating in the air. Within the exhaust box is, therefore, always found a very dusty atmosphere. Now when a light is introduced into an atmosphere of flour dust, the fine division of the flour so facilitates its rapid combustion that the flour is resolved into gases whose volume is much increased by the high temperature, so that a veritable explosion takes place, which explosion is most powerful when a certain volume of the gas is mingled with a larger proportion of air. In order that the explosion may be destructive, it is necessary that the dusty atmosphere be more or less closely confined within a given space. The most common cause of a spark or flame in the flour-mill is by the running of the feed off the stones, whereby the stones come down against each other, and quickly strike fire and become very hot. A very slight obstruction in the pipe is sufficient to so diminish the supply of grain as to allow the stones to come in contact with each other. Sometimes, again, a nail or a stone goes down with the feed, and causes sparks of fire to be struck off. Several occasions are recorded in which a crackling noise as of a running fire has been distinctly heard in the conduits leading from the stones to the exhaust pan. These slight explosions often blow open the fan box. If the flame passes the fan, however, and gets into the exhaust box, every thing depends upon the momentary condition of the air in the exhaust box at the time, as to whether the explosion shall end there, or the mill itself be blown up. The precautions to be taken in order to avoid all mill fire explosions consist specially in removing the exhaust box, stive rooms, smut rooms, and other receptacles of flour dust, to the outside of the mill. Still better is it if the conduits be provided with sliding or hinged valves which would close at once if an explosion occurs in any of the dust receptacles. Numerous other valuable suggestions are contained in Dr. McAdams's paper.—*Transactions of the Royal Scottish Society of Arts*, IX., 42.

TYRIAN-PURPLE INK FOR MARKING LINEN.

Von Bele gives the following method for preparing an ink for marking linen and cotton: Neutralize 75 grains of carbonate of ammonia with pure nitric acid, and triturate 45 to

60 grains of carmine with the solution. Mordant the fabric with a mixed solution of acetate of alumina and tin salt, and write upon it, when it is perfectly dry, with the ink.—18 *C*, *March* 5, 1876, 160.

INCREASING THE ADHESIVENESS OF COURT-PLASTER.

Court-plaster applied, as is usually done, by moistening it with the tongue, does not adhere well, on drying, to the unabraded skin adjoining the wound. By moistening the back of the plaster after it has been applied with glycerine, or, still better, by moistening the adhesive side of it when about to apply it with water to which one tenth of glycerine has been added, instead of with the tongue, the plaster will be kept adhesive and soft.—4 *C*, VIII., 1875, 72.

WATER-PROOFING UMBRELLAS, ETC.

Fischer, of Erfurt, suggests that, by the following treatment, umbrellas of alpaca, etc., can be rendered water-proof without impairing their color, flexibility, or durability, so that they will not become heavy with rain, and can be put away immediately after use without necessity for drying: Dissolve one part of shaved paraffin (a piece of paraffin candle will answer) in 10 to 15 parts of benzol by shaking it in a bottle. Pour the solution over the whole of the expanded umbrella rapidly in spiral lines, beginning at the top. Great care should be taken not to conduct the operation near a lamp or stove.—8 *C*, *August* 26, 1875, 312.

IMITATION OF STRAW, LEATHER, AND WICKER-WORK.

Imitations of straw, leather, wood, and wicker-work articles are produced by Löwenberg by the following process: A mould of the article to be imitated is made by pouring around it a mass consisting mainly of glycerine and glue. Into this, when firm, a liquid consisting chiefly of glue, glycerine, oil or soap, and some pigment, is poured, and before the whole of it sets the larger part is poured out again, leaving but a comparatively thin film, which constitutes the imitation when firm. Adhesion to the mould is prevented by treating it with chromic acid or acetate of iron.—6 *C*, *September* 9, 1876, 358.

L. MECHANICS AND ENGINEERING.

PRESERVATION OF WOOD.

According to Lostal, wood is rendered quite hard, and capable of resisting decay for a long time, by covering it in a large cistern with unslaked lime, and adding water from time to time until the lime is slaked, and allowing it to remain, according to the size of the pieces, until it is sufficiently penetrated by the lime-water; for that to be used in mining operations a week will suffice.—18 *C, February* 9, 1876, 95.

CARBOLIC ACID AND THE PRESERVATION OF WOOD.

The impression that a solution of carbolic acid has a preservative action on wood, founded on the assumption that tar preserves wood by reason of the carbolic acid and creosote it contains, is asserted by M. Boucherie to be entirely erroneous. Samples of different kinds of wood impregnated with one-half per cent., one per cent., and two per cent. solutions of carbolic acid, and then buried in a soil rich in humus, were found to be as completely decomposed after six years as samples that had not been so treated, while others impregnated with one and a half per cent. solution of sulphate of copper were unchanged.—28 *C*, IV., 66.

NEW PROCESS FOR THE PRESERVATION OF WOOD.

A new process for preserving wood from fire and decay has been invented by Messrs. Weatherby and Moore. It consists first in kiln-drying the wood, which deprives it of all moisture, and much of its volatile turpentine and other inflammable matters. It is then put into suitable cylinders, in which lime and water, with sulphurous acid gas, are forced into the pores of the wood under considerable pressure. The wood is removed, dried, and is then ready for use. The chemistry of the process consists in the formation of a soluble sulphate of lime by means of the sulphurous acid and the lime; this crystallizes as a bisulphite, which oxidizes and is converted into the sulphate of lime or gypsum. As this is an exceedingly insoluble salt, it is not easily removed from the pores

of the wood, and not only by its presence protects it as a non-conductor of heat, but deoxidizes all matters which are likely to prove objectionable as ferments.—1 *A*, XXXI., 75.

NEW PROCESS FOR INJECTING TIMBER.

In this process, the invention of Mr. G. B. Smith, any antiseptic compound that may be preferred is applied in solution directly to the end of the green log, and by the application of hydraulic pressure is forced to enter by the natural sap channels of the wood, by which operation the sap is forced out at the other end. The necessary pressure is maintained by the use of an ordinary hydraulic pump until all the sap is expelled, and the preserving solution appears in full strength at the farther end, when the thorough saturation of the log is most effectually assured. The mechanical appliances are simple, consisting merely of a cast-iron cap, fitted tightly against a metal ring driven into one end of the log, by means of a chain, or rod, and clamp passing over the other end, and communicating directly with the pump.

IRON AND STEEL FOR BOILERS, BRIDGES, ETC.

At a meeting of the Franklin Institute, committees were appointed to investigate the subject of the strength of iron and steel, with directions to make such experimental trials as may be necessary to include materials such as are at present found in the market, and employed for the construction of boilers, bridges, and other structures of iron and steel. In pursuance of this resolution, the sum of $1000 was appropriated for the purpose of defraying the cost of the purchase and preparation of samples of iron and steel for the testing-machine.—7 *D*, *September*, 1875.

CAST STEEL FOR LOCOMOTIVE BOILERS.

According to the Society of German Railroad Engineers, the use of cast steel for locomotive boilers has not been so satisfactory as was expected.—18 *A*, XXI., 89.

BESSEMER PROCESS WITH HOT BLAST.

Heyrowsky states that during the summer of 1874, at the Bessemer works in Zeltweg, fifty to sixty charges were made simply with a hot blast of about 1200° with cast iron, the an-

alysis of which gave 0.8 per cent. silicon, 2.23 per cent. carbon, and 2.2 per cent. manganese. After the fusion it contained 0.7 per cent. silicon, 2.3 per cent. carbon, and 1.3 per cent. manganese. The charges were very hot, and the expectation, founded on theoretical considerations, that a slightly carburetted iron could be Bessemerized with hot blast, was confirmed. A larger than usual quantity of ends of rails could also be thrown in, amounting to eighteen per cent. instead of twelve per cent., as with cold blast. Among the practical difficulties that prevented its continuous use was the decided effect upon the lining, which often became useless after two charges, instead of withstanding an average of fifteen or sixteen; and, besides, all portions in contact with the hot blast were so intensely heated that they rendered manipulation difficult, and it would require long practice to accustom the workmen to the heat. For this reason the use of the hot blast was abandoned for the present, although the results were considered favorable.—13 *C*, *July* 1, 1875, 851.

EXTENDED SERVICE OF A FURNACE.

The Emma Furnace managers have communicated to the *American Manufacturer* the extraordinary announcement that the furnace stood banked up from December 4, 1874, to July 9, 1875, without blast or draught, during a most severe winter. This is equivalent to seven months and five days, or 217 days, and during all of this time it held its fire intact without chilling or cracking. On December 4th the iron was run out, and the furnace filled wholly with Connellsville coke, every precaution being taken to have the fire remain until advisable to resume operations. It stood idle until January 9, 1875, and during this entire time not a thing was done to it, or a pound of fuel added. When opened at above date some two thirds of its coke was alive, and the furnace, after clearing away ashes, etc., was ready to resume operations. This record of the "Emma" has to our knowledge never been equaled.

REVOLVING FURNACE BARS.

Foreign technological journals find a very considerable improvement in furnace grates in an invention of M. Eloy Schmitz, who replaces the straight fire-bars ordinarily used

singly or in pairs, by hollow cylindrical bars pierced with holes, and so arranged as to revolve readily. The new fire-bars rest on supports which are themselves cylindrical and hollow; they are supported lengthwise by a plate fixed beneath the door of the fire-box, and fitting into a neck made at the near end of the bar. With this construction, it is affirmed, the duties of the stoker are rendered much less important and troublesome, and a very material economy of fuel is effected. The following advantageous features are claimed for it: The layer of coal resting on the grate may be doubled in thickness, thus obviating the necessity of frequent charging and the entry of cold air into the fire-box. The interior of these hollow bars being always visible to the stoker, he is able to observe any choking of the air passages as soon as it takes place. It is only necessary for him then to give the bars a fractional turn with the winch, and a clear surface, free from slag and scale, is presented to the fuel. This is accomplished without opening the doors and admitting an excess of cold air. The rotation of the bars has the additional beneficial effect of clearing the obstructed part and throwing down into the ash-pit the ash and other non-combustible impurities, the retention of which retards combustion. The economy of fuel which is claimed for the new construction is of even more importance than the economy of labor.

AMERICAN MINING METHODS.

One of our Comstock mining engineers, lately returned from a tour of inspection through the mining districts of Germany, communicates to a California daily his conviction that there is no engineering in Germany to compare with that on the Comstock lode, and no mines in which the mechanical appliances are so ingenious and effective. He supports this assertion by a graphic description of the crude and primitive methods in vogue abroad. He remarks that in the deep mines of Bohemia the hoisting apparatus consisted merely of open tubs, and the operating machinery was so poorly constructed that he dared not venture to descend. In most of the German mines, he found that the men were compelled to walk up or down to the scene of their labors, either by going down an incline, or by using long parallel stilts, which move up and down alternately about six feet at a time. The mode

of ascending and descending on these is to step from one to the other, as each ascends or descends, where a misstep would be attended with fatal consequences. His remark that in the Comstock the men went down to the lowest levels and came up in two minutes without the slightest exertion was received politely but incredulously. The character of the mining tools employed is criticised in the same uncomplimentary strain, and the assertion is made that an average day's work upon the Comstock would seem incredible to the miners of continental Europe.

STATISTICS OF STEAM.

Statisticians calculate that there are now in work some 200,000 steam-engines, with a total power of 12,000,000 horses, corresponding to the muscular strength of 100,000,000 men.

CASING FOR STEAM-PIPES, ETC.

The following composition is recommended by Dr. Springmühl for coating steam boilers, pipes, etc., by laying it on from three quarters of an inch to one and a quarter inches thick, according to the size of the object: White pipe-clay, 30 parts; fire-clay, 25 parts; powdered charcoal, 20 parts; rye-flour, 7 parts; boiled linseed-oil, 5 parts; cow's urine, 3 parts.

CASING FOR STEAM-PIPES.

The German *Journal of Woolen Manufactures* gives the following for casing steam-pipes: Mix fuller's earth, that has been used and collected in sinks for this purpose as well as to prevent the filling of streams, with fully the same quantity of coal-ashes, and add to the pasty mass as much calf's hair as it will take up. Before laying it on add one eighth its quantity of calcined gypsum, and lay it on in thin coats. If the first layer does not adhere well, unused fuller's earth may be used for it.—23 *C*, VII., 50.

ANTI-FOULING COMPOSITION.

It is said that the copper sheathing of the two royal English yachts *Alberta* and *Elfin* were in 1873, at the command of the Admiralty, painted with Jesty's patent anti-fouling composition, in order to prevent the adhesion of sea-grass and

other substances. These two vessels have been again docked in Portsmouth, having in the mean time lain principally in harbor. The test of Jesty's composition was very satisfactory. All portions of the sheathing were found to be free from algæ or other substances, and remained precisely as they were at the time they were first painted, excepting some very small spots under the stern, where a green slime had formed of the thickness of a sheet of paper.—*Mitth. Oesterr. Hydrog. Bureau*, 1874, 494.

PREVENTION OF BOILER INCRUSTATIONS.

Lesueur proposes the use of metallic zinc as a preventive of boiler incrustation. Twenty kilogrammes, introduced into a boiler of 100 horse-power, is sufficient for at least three months. The zinc disappears, and whatever is deposited from the water forms no crust, but only a loose mass which can easily be washed out. The mode of action is not yet explained, but M. Lesueur supposes electrical force to be involved. A galvanic couple may be formed by the zinc with the metal of the boiler, so that a little water would be decomposed. Thus a film of hydrogen might be produced and continually renewed on the surface of the iron, preventing the adherence of any deposit.—*Ann. de Ch. et de Phys.*

APPARATINE, A NEW ANTI-INCRUSTATOR.

A new anti-incrustator has lately been introduced under the name of apparatine, which is prepared by stirring up sixteen parts of potato starch in seventy-six parts of water, and then adding eight parts of potash or soda lye, at 25° Baumé, the whole to be thoroughly mixed together. In a short time the mixture forms a thick jelly, and it is then beaten up vigorously for a time, when it forms a colorless, transparent substance, slightly alkaline to the taste, and of a strong glue-like consistency. It dries slowly in the air without decomposition, and when perfectly dry resembles horn, but is more flexible. When introduced in small quantity into steam-boilers it prevents their incrustation. It is also capable of nearly all the applications of ordinary gelatin, and is especially adapted for sizing textile goods of all kinds, imparting to them a hitherto unattained smoothness. When once applied to goods and dried it is perfectly insoluble, as three or four

washings in hot water have proved to have no effect upon it. It can also be used as a thickening in calico-printing. Several of the technological journals speak of this substance as a very important addition to the resources of the dyer and manufacturer. Care must be taken to retain it in air-tight vessels until it is used, as it is not easily rendered soluble again when it has once become hard.—18 *A*, XXI., 29.

MINERAL PRODUCTS OF EUROPE FOR 1874.

The Austrian statistician Brachelli estimates the total mineral product of all the countries of Europe for 1874 to have been as follows: Platinum, 1025 kilogrammes; gold, 6900 kilogrammes; silver, 300,000 kilogrammes; pig-iron, 240,000,000 hundred-weight; copper, 600,000 hundred-weight; lead, 5,300,000 hundred-weight; zinc, 2,700,000 to 3,000,000 hundred-weight; tin, 205,000 hundred-weight; coal, 4,376,000,000 hundred-weight; salt, 95,000,000 to 100,000,000 hundred-weight; manganese, 1,616,000 hundred-weight; antimony, 5700 hundred-weight.

PRESSURE GAUGE TO REGISTER 54,000 POUNDS.

A mechanical novelty worthy of being placed on record is a mercury column pressure gauge lately completed by Thomas Shaw, of Philadelphia, for a company in that city, which is capable of registering a pressure of 54,000 pounds to the square inch. The body of this gauge was forged solid from the best Midvale steel, and bored and turned to the proper shape. The total height is six feet, that of the mercury column being four and a half feet. The area of the large plunger is six and a half inches, and of the small one three sixteenths, and the movement about one thousandth of an inch. No gauge has yet been built to register so high a range of pressure as this one.—18 *A*, XXI., 35.

INCRUSTATION OF BOILERS.

At one of the recent meetings of the French Academy, this important subject was discussed. M. Lesueur, a telegraph inspector, sent a communication to the Academy setting forth the efficacy of zinc in protecting steam-boilers from incrustation. The substançe of M. Lesueur's remarks was to the effect that in many instances the action of zinc

for this purpose had been found to be excellent, the deposit of scale being small in quantity, and easily removed. These statements met with considerable opposition. It was asserted that in many cases where it had been applied the zinc had failed entirely to produce any useful effect; and a number of authorities were quoted to prove that the success of the zinc or "galvanic" process was at best questionable. The opinion prevailed that in view of the vast differences in the nature of the feed-water employed in different localities, there could scarcely be any universal panacea for the evil of boiler incrustation.

AN AUTOMATIC RELIEF-VALVE FOR STEAM FIRE-ENGINES.

The damage caused by excessive flooding with water at fires frequently exceeds that by fire, and any appliance that prevents this is deserving of recognition. The Committee of Science and the Arts of the Franklin Institute lately awarded the Scott Legacy Premium and Medal to John E. Prunty, of Baltimore, for his automatic relief-valve for steam fire-engines, designed to give the pipeman full and instant control of the stream, enabling the latter to shut off instantly to prevent damage by water, to change nozzles, or to move the hose easily. The valve is applied between the pump (or hydrant) and the hose, and consists of a barrel-shaped chamber, with an auxiliary cylindrical valve-chamber parallel to this, and communicating therewith by two ports. A double beat valve in this latter chamber allows, when open, the exit of water from the main chamber through an eduction port. To the stem of this valve is attached a lever with ring-shaped termination floating freely in the main chamber. The areas of this ring and of the poppet-valves are so proportioned with respect to each other and the cut-off nozzle at the end of the hose line, that when the nozzle is open and the current unobstructed the water will pass through the main chamber to and through the hose; but any stoppage of the current by means of the cut-off nozzle, or from a wall falling on the hose, etc., allows of the instant opening of the balanced valves and the discharge of the water through the eduction port, which has a larger area than the nozzle. The water so discharged may, if desired, be returned to the suction side of the pump. Being entirely automatic at any pressure, and

operating without any increase of pressure upon pump or hose line, the valve largely increases the efficiency of the engine to which it is attached.

SELF-WATERING LOCOMOTIVES.

One of the most practical improvements which is coming into very extensive use in this country is the self-supplying water-apparatus for locomotives. As the following description will show, the devices employed are at once simple and efficient: A water-trough from eight hundred to twelve hundred feet long is laid between the tracks of the railway, and as the engine passes along at a velocity of, say, twenty miles an hour over the trough, the fireman, by means of a lever, lowers one end of a pipe, and the water is scooped up, as it were, into the tender. In winter the water in the trough is prevented from freezing by means of steam-pipes. The convenience of this device is not its only meritorious feature, for, in addition to this, it saves considerable time in stoppages at watering-stations, thus permitting a more moderate rate of speed to be maintained—a practice which realizes material economy in the running of trains.—6 *D*, XXXII., 245.

STATIONARY HYDRAULIC ENGINE FOR RAILWAYS.

The application of the hydraulic power to the movement of a system of belts or bands in working stationary railroads, especially in mines, forms the subject of a memoir, by Cavallero, lately communicated to the Academy of Sciences of Turin, in which he specially discusses the methods invented by Aguido, and applied by him to several roads in Italy. The theoretical investigation of Cavallero is supplemented by a numerical application to the apparatus established on the inclined plane at Lauslebourg.—*Atti della R. Acad. della Scienza, Turin*, 1875, L., 577.

ELECTRO-CAPILLARY MOTOR.

A curious little engine, termed an electro-capillary motor, has been described by M. Lippmann. If a globule of mercury be placed in a saucer, together with a little solution of potassium dichromate, acidified with sulphuric acid, and it be touched upon the side with a point of iron, it will at once contract laterally, drawing itself away from the iron. This

will break the contact; gravity will spread the globule out again, when it will again touch the iron and contract; and so on. The explanation of this phenomenon is to be found in the fact that the electric current developed on contact of the two metals changes the capillary constant of the mercury, and hence its form. This is the action which M. Lippmann has utilized in his motor. In a glass tank filled with diluted sulphuric acid are two small cylinders containing mercury. A bundle of capillary tubes, open at both ends, is placed in each cylinder, resting on the mercury, each bundle being connected above with one end of a walking-beam, to the prolongation of which is attached a connecting rod, crank, and fly-wheel. By means of a commutator on the axis of the fly-wheel, the mercury in each cylinder is alternately connected with a small battery; its capillary constant is changed, its ascent in the tubes increased, that side preponderates, and causes a semi-rotation of the fly-wheel. This sends the current to the other cylinder, which, acting similarly, completes the rotation. As many as one hundred revolutions per minute have been obtained with this engine. Conversely, on rotating the fly-wheel by hand, a galvanometer in the current indicates the production of an electric current.—3 *B*, XXXV., 5.

RAILWAY SIGNALS AND BLOCKS.

The Highland Railway of Scotland has introduced upon its road what the English journals describe as a novel and ingenious combined block and signal system, the invention of Dr. Whyte, who has devoted several years to the work of improving the mechanical arrangements for operating railway trains. The system is entirely self-acting, and its operations are performed with the agency of an electro-magnetic machine of simple construction. An engine running past, say two stations, blocks the line at the first by raising a semaphore; places an automatic check against the passing of a second engine by the ringing of an alarm-bell on the second engine itself, should it attempt to follow; announces its approach to the second station, or can be stopped by the station-master there; while on reaching that station it clears the line at the previous one of both semaphore and alarm-bell, so as to leave it free for any approaching train. The

apparatus itself may be divided into two parts, one being on the engine, and the other connected with the line. Four wire brushes, each pair metallically connected, are suspended from the engine, one pair having a battery and bell in circuit, and the other a bell. A wheel descends alongside these brushes. On the line, between the rails, at such distances as may be thought requisite, or in close proximity to each station, a series of insulated metallic plates, in an air-tight box, are laid down, each plate being from five to ten feet long. By the side of each pair of plates, the ends of which are connected by wires, is placed an electro-magnet, with wires from a battery attached. The keeper of the magnet is fixed to a lever by means of a pulley, and as the engine travels past this lever is pressed upon by the wheel above mentioned, and the keeper is forced up against the poles of the magnet. Thus the semaphore arm is raised and the line effectually blocked. With the view, however, to guard against a possible inattention on the part of the driver of an engine approaching the apparatus, the box is left in such a position that should his engine pass over it while the signal is up the alarm-bell on the engine itself is instantly rung. The first engine having successfully blocked the line in the rear, proceeds to the next station or signal-post, where the line is again blocked; and by means of wires to the last box and mechanism similar to that above described, the electro-magnet at the former station is released, the semaphore lowered, and the way left clear between these two sections. Thus it is clear that each train protects its rear for the distance between each pair of plates. The line being, as it were, divided into sections, each train as it enters a section instantly blocks it so that no other train can follow until the first has proceeded without the bell being rung as a warning. Connected with this automatic electrical block system is an arrangement by which each train can announce its approach to any station, and another for giving the station-master the power to stop a train by causing the bell on the engine to ring. The brushes on the engine are the means by which this is accomplished; a powerful battery placed at one station, or smaller batteries placed in suitable positions along the line, being the agency by which the apparatus is operated. As these batteries are never in circuit except when a train works

them, the waste is reduced to a minimum. The advantages claimed for this system are that, being self-acting, it entirely dispenses with manual labor, which at some critical moment is apt to be at fault; that its certainty of instantaneous action is secured by the concealment of its working parts, and their protection from wet and dust; and, finally, that the expense of application is comparatively small.—3 *A*, VI., 16.

A NEW MOTOR FOR SMALL MACHINES.

By a recent invention of Schneider, of Vienna, the application of steam as a motor for small machines, it is said, has been rendered perfectly successful. The apparatus is small and noiseless; and, considering the fuel consumed and attendance required, as well as the first cost, it is claimed that it affords the cheapest possible power for small machines, while, on account of the diminished size of the boiler, it is available any where, without any alterations in the buildings, as in the foundations, chimneys, etc. Pending the application for a patent, full details can not be given; but a chief feature is that the water is carried back from the cylinder into the boiler in such a way that a boiler of not quite twenty-one gallons capacity affords steam of four horse-power.—5 *C*, II., 1876, 15.

NEW OIL-CAR.

The present method of transporting oil in tanks to the seaboard involves the necessity of returning the tank cars empty —which means so much dead loss in freight to the transporting companies. A new tank car has lately been invented, which is designed to get over this objection by swinging the tank underneath a platform, which can be used as an ordinary gondola car for carrying freight on the return trip. If found successful in practice, the new design should materially lessen the cost of transporting oil to the seaboard.

A NEW PLAN OF ELEVATED RAILROAD.

An experiment was lately tried at the works of the Phœnix Iron Company, at Phœnixville, Pa., with a new form of elevated railway, which is claimed to possess decided advantages. In view of the general interest manifested in the rapid-transit problem, the following brief description of the

system in question is presented, although without the aid of drawings a description must necessarily be unsatisfactory:

The railway is constructed on the plan of a single rail, supplemented by two guide-rails parallel to it, the centre rail supporting the car. The road is designed to be elevated about fourteen feet above ground-level, and the advantages claimed for it are that the guide-wheels, which maintain the equilibrium of the car, being connected with the bearing-wheels, maintain a constant position with relation to the bottom rails, however much the car may rise and fall on its springs. The short axles of the bearing-wheels, with a slight flexibility on the bearings, enable them to adjust themselves to any curve independent of the car and of each other, thus avoiding the danger of mounting the rails, and permitting very short curves to be employed. The roadway is supported on Phœnix columns placed about fifty feet apart. The engine is likewise of peculiar construction. The results obtained at the trial were pronounced to be quite satisfactory. Without the least irregularity of motion on the curve, a speed of forty miles an hour was maintained, with a car weighing 11,000 lbs., and an engine weighing 8000 lbs.—20 *D*, *Oct.* 14, 1875, 11.

A NEW RAIL FOR STREET RAILWAYS.

The common form of street rail possesses several disadvantageous features. Of these the most obvious and objectionable are: First, the battering down of the rail end by the sudden impact of the car wheels; and, second, the loosening of the permanent way by the gradual drawing of the spikes, due to the lever-like action of the wheels on the ends. A recent invention, which is termed a compound street rail, is claimed to have obviated these disadvantages, and to give to the road additionally greater rigidity and wearing qualities. The compound rail has its chief claim to novelty in the fact that it consists of two parts—the head and foot, or flange. A section of the rail, with the two pieces in position, would resemble that of a common street rail divided horizontally into an upper and lower piece. These pieces are so laid down that the joints or ends of each of the upper pieces or heads shall fall at the centres of the flanges. In thus

breaking the joint, the lower piece is made to act as a continuous support or bearing to the rail-head throughout the whole line of rail. The sides of the flange throughout its whole length are bent at right angles to its face, and in opposite directions. This device leaves an upturned edge of about a half-inch of metal on each side, its object being to afford a brace to the rail-head, to enable it to resist the obvious tendency to lateral displacement which will be brought to bear upon it by the turning out of carts, wagons, etc., and likewise to give the flange a firmer hold upon the stringer. When the flange is worn upon the upper surface, it may be taken out and reversed, thus exposing an entirely new surface to wear. The compound feature of the rail likewise permits different materials to be used in its construction; the upper piece, for example, may be made of steel and the flange of iron, or both may be of steel. The parts of the rail are attached firmly to each other and to the wooden stringer by clamps and keys of peculiar construction. By this means the employment of spikes in the head of the rail, which would be open to grave objection, is rendered unnecessary, and the rail is more securely fastened down than would be possible by the use of the ordinary spike. The inventors claim that their rail does away with the hammering down of the rail ends by affording for the head a continuous, stiff support; that it is far more rigid and permanent than the common rail; and that its wearing qualities are greatly superior. A line of this rail is about to be laid down near the entrance to the grounds of the Centennial Exhibition in Philadelphia, where the claims of the inventors will be most thoroughly tested by the enormous traffic that must pass over it.

IRON SLEEPERS.

On the railroad lines of Alsace-Lorraine efforts are being made to create a system of steel rails with iron sleepers. Cross-girders of broad section are used to support the rails; and these are strengthened at certain distances by tension-rods, which give a steadiness of support which permits of the use of a lighter style of rail. In the same connection, it is worth recording that M. Loigné has patented a system of U-shaped grooved cross-stays of iron to replace the wooden

sleeper, which latter is often found, especially in narrow-gauge roads, to take up too much room, and to occasion frequent repairs. In India iron sleepers have long been in successful use—the destructive habits of the ants rendering the use of timber quite impossible.

SINGLE-RAIL STEAM TOWAGE ON CANALS.

The following is a description of a method of steam towage lately introduced on the Bourgogne canal in Belgium. The tow-path is laid with a single rail, weighing some sixteen pounds to the yard, and fixed on traverses placed 3.2 feet apart. The locomotive has four wheels, two of which are placed directly along the axis of the vehicle, one in advance of the other, and the other two opposite each other at the sides. The first-named pair are directing, and the last-named driving wheels. The directing-wheels are grooved and fit the rail; the others have rubber tires that give purchase on the macadamized road. By means of simple mechanism the weight of the engine may be thrown either on the driving or directing wheels at pleasure. In the first case the maximum, and in the latter the minimum of adherence is obtained, to correspond to the condition of a loaded or empty boat. A single road is employed with relay engines provided at suitable distances. Each locomotive tows one boat, and when a meeting takes place of two traveling in opposite directions, the engines change boats and retrace their paths. The single rail system has already been satisfactorily tested for short distances on the Belgian canals; and the system here described will extend its application over a distance of 150 miles. The locomotives are described as weighing four tons each, and travel, according to statement, 3.1 miles per hour, with full boats carrying a cargo of 150 tons each.—17 *D*, XIX., 54.

CAST-STEEL WIRE ROPES.

According to a Prussian mining journal, cast-steel wire ropes have been substituted in many mines in Westphalia for those of iron, with excellent results. Experience in all cases, however, indicates that steel wires must be greased at least once a week, and that it is advisable to lay the rope aside upon the slightest indication of brittleness in any of the

wires. At Saarbrück it has been found advantageous to use a drum of larger diameter than is usual with iron wire, owing, it is presumed, to the fact that steel breaks more readily than iron after it has passed the limit of elasticity. —5 *C*, XLVIII., 376.

SUBMERGED CHAIN FOR TOWING BOATS.

The remarkable success attending the novel system of river navigation, introduced for nearly the whole length of the Elbe River, of towing boats by the aid of a chain submerged in the channel, has led to its introduction upon the tributaries of that river. The data furnished by its operation for several years warrant the conclusion that this mode of interior navigation possesses great economical advantages, not only especially as compared with railroads, but also as compared with other modes of towing. By the former methods of towing, the necessity for the reduction of the resistance to a minimum led to the building of boats of large size, regardless of the disadvantages connected with them, such as the greater difficulty of obtaining full freight from point to point, uncertainty of running at all stages of water, etc. But besides the reduction of the size of boats allowed by the new system, it is also probable that it will be found applicable in cases where the current has been found too strong to render navigation practicable by the old method, since a boat towing by means of a firmly anchored chain passing over it is much more nearly independent of the current.—34 *C*, II., 14.

WIRE ROPES OF PHOSPHOR-BRONZE.

On account of the higher absolute tenacity and power of resisting torsion possessed by phosphor-bronze wire of certain kinds over that of iron or steel, its advantageous application in the manufacture of wire ropes for mines was anticipated. The employment of such ropes for several years in England, Belgium, and Westphalia has so completely substantiated the theoretical calculation that their use is rapidly becoming more general. Their first cost, it is true, is greater than of those of iron or steel, but, on the other hand, they afford much greater security, last at least seven times as long as those of steel, and, when unfit for use, the

metal is still worth a large part of the original cost.—5 *C*, XLVIII., 385.

PEAT AS LOCOMOTIVE FUEL.

Any method of treating peat, to enable it to be utilized on a large scale, would be of great importance; in which connection it is of interest to notice that the Central Pacific Railroad Company have experimented successfully with this substance as fuel for their locomotives. Their supply was obtained from an island at the junction of the Sacramento and San Joachin Rivers in California.—4 *D*, *October* 7, 1875, 15.

THE PNEUMATIC TUBE IN THEORY AND PRACTICE.

Mr. Culley communicates to the Institute of Civil Engineers, of London, an elaborate memoir on the transmission of telegrams by pneumatic tubes. This, he says, was first carried out in 1853 by Mr. Latimer Clark for the Electric and International Telegraph Company in London. Both the compressed air and the vacuum methods have been used in England; and tubes having diameters of from one to three inches are adopted according to the necessities of traffic. The methods adopted in London appear to secure decidedly greater speed and certainty than those used in Paris. The British public, it is stated, is perhaps exacting in its demands for speed. A delay of ten minutes would be considered fatal in the metropolitan traffic. As regards the comparative cost of the pneumatic and the electric systems, it is stated that the former is decidedly less expensive, since, for instance, the total annual expense of the tube system in London, including the pay of all engaged in it, and the interest on the original cost, is barely two thirds of the pay alone of the staff that would be required to telegraph the messages. The theoretical principles which govern the flow of air through pipes, and the amount of engine-power required to produce that flow, has been very thoroughly investigated by the telegraph officials of England, and the results of their investigations are given by Messrs. Culley and Sabine in the present memoir. A number of experimental determinations were made by using the tubes when business was not pressing, and the results thus obtained appear to verify the theoretical formula.

The memoir is accompanied by extensive tables to facilitate the solution of the problems arising in pneumatic transmission.—*Minutes of the Proceedings of the Institution of Civil Engineers, London*, 1876, 53.

PNEUMATIC TUBES IN PARIS.

In a memoir by C. Bontemps on the movement of air in pneumatic tubes, a very complete account is given of the system of pneumatic transmission as at present existing in Paris. He states that when an obstruction exists any where in the underground tubes, its location is determined by firing a pistol into the tube; the resulting wave of compressed air, traversing the tube at the rate of a thousand feet a second, strikes the obstruction, and is then reflected back to its origin, where it strikes against a delicate diaphragm, and its arrival is recorded electrically upon a very sensitive chronograph, on which also the instant of firing the pistol had been previously recorded. The wave of sound on reaching the diaphragm is recorded, and thence reflected back, and a second time strikes the obstacle, and returns to the diaphragm. This operation is several times repeated, so that several successive measurements can be made of the time required by the sound-wave to traverse to and fro within the pneumatic tube.—*Minutes of the Proceedings of the Institution of Civil Engineers, London*, 1876, 105.

PRINCIPLES OF THE CONSTRUCTION OF WHEELS.

In an essay on the construction of wheels and axle-trees, Captain Kemmis, of the Royal Artillery, states that the most severe test to which spokes are subject is from the lateral thrust brought to bear upon the nave when one wheel becomes lower than the other by dipping into a rut. In order, therefore, to place them in a better position to resist this thrust the wheel is dished, or formed into a kind of dome, and just as the dome or arch is strong from its form to resist pressure upon the crown, tending to crush it in, so is the wheel made strong by the dish to resist the lateral thrust tending to throw the nave outward. In fact, not only do the spokes, sustained by the tire, give mutual support to each other, but the lateral thrust upon each becomes partly converted into a compressing strain which the wood has bet-

ter power to resist. The greater the dish the stronger the wheel will be to resist the lateral strain; but no more dish should be given than necessary for the safety of the spoke, by reason of other considerations. Among these considerations the principal consists in this, that by reason of the dish form the sole of the wheel must be leveled, making the wheel conical in form instead of cylindrical. The wheel, therefore, tends to describe a circular path around the point where the prolongation of its sole would meet the prolongation of its axis. In every vehicle the wheel is compelled to move straight forward; consequently, instead of rolling, it partly slides, producing thereby a friction between the ground and it, and tending thereby to defeat the primary object of using wheels. This latter point has been minutely investigated by Colonel Close, who states that the force wasted in overcoming this friction varies directly as the square of the breadth of the tire, and as the tangent of the hollow of the axle-tree arm of the wheel, but inversely as the height of the wheel. If, then, on grounds of strength, a certain hollowing of the axle-tree arm is unavoidable, we see how essential it is to confine the width of the tire within the lowest allowable limits. Colonel Close states that, as the results of several years' experience in the manufacture of heavy carriages for army purposes, he is led to the following considerations: First, in the case of carriages loaded heavily and drawn over irregular and broken ground, a dish is of the utmost value to strengthen the wheel, whether the carriages be on springs or not. Second, in carriages not supplied with springs, and liable to carry dead loads over all sorts of country, the lower spoke should be almost, but not quite vertical. Third, if the carriage be on easy springs, considerable dishing of the wheels is admissible, without hollowing the arm. The wheels would then be cylindrical, and would roll truly. In this case the strut of the lower spoke is equal to the dish of the wheel.—*Minutes of Royal Artillery Institution*, VIII., 372, 418.

SCIENTIFIC BALLOONING.

Since the death of Crocé-Spinelli and Sivel, the taste for balloon ascensions, so far from diminishing, seems to have received a new impetus in France, in all parts of which country ascensions have of late taken place very frequently. The

greater part of the aeronauts content themselves with sending some account of their voyages to the local press; but such accounts, however brilliant they may be in a literary point of view, are of little use to meteorological studies. The French Society for the Promotion of Aerial Investigation has consequently requested all the aeronauts of that country to send to it, as the central bureau, careful accounts of the voyages made by the aeronauts, giving the barometric heights, the direction and velocity of the winds and clouds as well as of the balloon, the temperatures, and, if possible, the hygrometric conditions. By thus centralizing the observations, it is believed that a great service will be rendered to meteorology. And similarly it is earnestly to be desired that the aeronauts of America, both professional and amateur, would communicate to some central body—than which none can be more appropriate than the Army Weather Bureau—the exact results of their various ascensions.

RECENT PROGRESS OF AERONAUTICS.

In reviewing the recent progress of aeronautics, Villeneuve recently stated that Henry Giffard, who constructed the first steam aerostat, had, in the course of his studies, been led to invent the injector, which is known under his name, and which has given to him both a reputation and fortune, which he richly merited.—Paul Bert, in studying the influence of barometric pressure upon animal life, was led to a process for the preservation of the bouquet and the flavor of wine.—Of the great number of aerial voyages that have been made of late, those especially worthy of mention as having for their object the improvement of aeronautics, or the application of the balloon to the study of meteorology, physiology, spectroscopy, etc., are the following: First, that undertaken on the 22d of March by Crocé-Spinelli and Sivel. These two brave aeronauts ascended to the height of 24,000 feet—a height which had never been attained before in France. At this altitude, Spinelli was able to study spectroscopically the composition of the atmosphere of the sun. In the United States, Mr. S. A. King has made some very long voyages in pursuance of meteorological studies. M. Durnof and his wife ascended from Calais on a day of public festival, and were caught by a wind

which carried them to the middle of the North Sea. They were rescued by two brave English mariners. An interesting history of the balloon *Louis Blanc* has been published by Forcot, giving an account of the ascension made during the siege of Paris in the postal service.—Three balloon ascensions during 1874 were attended with the death of the voyagers; the first of these took place on the celebration of the crowning of the King of Siam, when a slave was carried up in a balloon without any provision for his safety.—For scientific applications of the balloon, meteorology takes the first rank. Their usefulness in the study of the winds in the midst of storms has been forcibly urged by Janssen, who has recently twice personally experienced the power of the typhoon, and has also established a prize medal of gold to be given to the author of the best memoir on aerostatic meteorology.—A curious apparatus has been designed by Parville for determining the true direction of the motion of the clouds, with respect to the meridian.—Self-recording meteorological apparatus has been invented by Messrs. Herve, Manyon, Olivier, and Jobert, while minimum barometers have been made by Janssen. Pénaud and Godard have devised apparatus to indicate the rising and falling of the balloon.—Crocé-Spinelli and Sivel have furnished the means for ascertaining the direction of the movement of strata of air, either above or below the balloon.—Miss Zier, granddaughter of Carcel, the inventor of the Carcel lamp, has proposed to do away with the lubricating oil, whose thickening is so injurious to the action of all self-recording apparatus at low temperatures, by mounting the movable portions of the mechanism on polished rubies.—One of the most important improvements in the gas balloon is that of Jobert, who proposes to construct one side of the gas-holder of white, and the other of black stuff, since it is easy to turn the balloon about its vertical axis by means of a small propeller, so as to keep either the black side or the white side always facing the sun, and thus, by the heating or cooling, make the balloon either to ascend or descend to an extent depending upon the difference in the reflecting or absorbing power of the two halves of the balloon. By this means we can, perhaps, control the vertical movements of the balloon to a sufficient extent to render its applications in meteorology of much importance.—

Numerous prominent aeronauts have warmly advocated the use of the hot-air balloon, the Montgolfier, and certainly these do seem highly appropriate to a certain class of meteorological observations.—Almost all the danger to the aeronaut is presented at the moment of his descent, in consequence of the difficulty of arresting the balloon without a sudden shock, and a consequent rupture when the wind is strong. Messrs. Sivel, Pénaud, and others have, therefore, made use of the friction of the anchor rope, which permits the gradual diminution of the motion of the balloon up to the moment when the anchor takes fast hold of the ground. The question of directing the movements of the balloon has, as for many previous years, been treated of by numerous persons, but, in general, without any great advance toward the desired end. It is but a step from the attempt to direct the passage of the balloon to the attempt to imitate the flight of birds, and in this branch of aeronautics there has been witnessed a marked advance. Important memoirs on this subject have been presented by Marey, Pénaud, Pettigru, and others.—A remarkable apparatus has been constructed by Grouchot for studying, by direct observation, the movements of the wings of birds.—*La Aéronaute*, 1875, 13.

AERONAUTICS IN THE ARCTIC REGIONS.

Sivel, in 1872, laid before the French Aeronautic Society a proposition for an exploration of the North Polar regions by means of balloons; and the idea has lately been treated of by Martinet, who states that Sivel's original project was the first that seemed to be worthy of serious attention, and to present practicable features. His idea was to make use of a large balloon filled with hydrogen, and so constructed as to remain for months in the air, to effect which latter desirable object Sivel indicated the exact means in order to keep the balloon at an altitude of about 2500 feet. Special means were necessary to overcome the variable effect of solar radiation, which, as is well known, produce variations in the altitude of a balloon to the extent sometimes of more than three thousand feet. Thus in the voyage of Janssen on the 22d of December, 1870, they were forced to seek an altitude of from nine to thirteen thousand feet, in order to escape being plunged into the surface of the sea by the

oscillations due to the heat of solar radiation.—*La Aéronaute*, 1875, 287.

THE PARAKITE.

An English aeronaut has lately invented a flying-machine to which he gives the above name, and with which a tolerably successful experiment is said to have been made at the Alexandra Palace. The machine in principle is substantially a kite, and like this is held by a cord, on the severance of which, however, the inventor affirms the apparatus will descend as safely and securely as a parachute. In the experiment referred to, the machine employed was thirty feet high and thirty feet wide. As soon as the sail was over the framework and the front or windward point of the parakite was raised, so as to allow the wind to touch the machine on its under surface, it was instantly converted into a concave form, and manifested symptoms of rising. The wind was blowing at the rate of about two miles an hour, but with this slight breeze Mr. Simmons was carried into the air. The inventor claims that his device can be used successfully in any wind ranging between four and forty miles an hour, and that an altitude of from six hundred to one thousand feet may be attained. The machine used on the occasion above named covered an area of seven hundred superficial feet, and its weight (exclusive of its occupant) was one hundred pounds. On a previous occasion some trials were made with a small parakite carrying a two-pound weight, which several times attained an altitude of one thousand feet, and remained tolerably steady, though its descent was rather rapid. These experiments, it is said, will be repeated, with the view of determining the practical utility of the device.—3 *A*, VI., 426, 490.

FLUID-COMPRESSED STEEL AND GUNS.

In a paper with the above title, read before the Institution of Mechanical Engineers, Sir Joseph Whitworth remarked that the difficulty he experienced in obtaining sound, ductile steel had induced him to institute experiments in compressing steel while in the fluid state. He affirmed that crucible steel for constructive purposes was largely superseded by the metal produced in the Bessemer converter or the Siemens furnace; and although the crucible steel was yet occasionally

demanded on account of its supposed superiority, nevertheless its superior quality, when it existed, would be found to be due to the use of purer and better materials. In substantiation of his opinions he exhibited specimens of fluid-compressed steel. For guns, torpedoes, boilers, etc., Sir Joseph stated that the quality of elongation was of the first importance, as well as generally, wherever severe strains were suddenly employed. He said that it was now possible by the compression of fluid metal to produce with certainty steel that would bear a tensile strain of forty tons to the square inch, and which elongated thirty per cent. of its length before breaking. He urged, in conclusion, that guns should be constructed of steel, and steel only. He detailed the results obtained in the experiments with his breech-loading guns, and added that the War Department were now making guns of enormous size and weight, but maintained that this great size was unnecessary, for the reason that, if monster guns were wanted, they could be made by means of the Siemens-Martin furnace and fluid compression at much less cost, while with regard to the quality of materials employed every thing favored the modern processes. On the subject of projectiles, the speaker asserted that long projectiles gave greater penetration at both long and short ranges, and also a much lower trajectory, except at the lowest elevations, for short distances, and he declared in favor of the polygonal system of shot over the French studded system adopted at Woolwich.—3 *A*, VI., 139.

RANGE-FINDER FOR ARTILLERY PRACTICE.

The range-finder of Captain Nolan of the Royal Artillery has been in use to a limited extent for some years, but a full account of the instrument, with tables for its use and instructions for its employment, both by infantry and artillery, has only lately been published by him. This simple instrument can, according to him, give the correct distance of an object in such a way and so quickly as to be perfectly applicable to the use of a battery in the field. Its success seems to have been so great in England that it is improbable that any instrument differing essentially in construction from it will be likely to supplant it. The cost of the artillery practice at unknown range, while manœuvring rapidly, shows that a

large quantity of ammunition may be wasted without the effect being observable from the battery, and points to the necessity of some means being provided for ascertaining in the field, and within reasonable limits, the distance of the object to be fired at. Captain Nolan's apparatus is fitted to two of the guns of a battery, and enables the distance of the object to be determined with sufficient accuracy after firing two or three rounds.—*Min. of Roy. Artillery Institution*, VIII., 161.

SHARP ARTILLERY PRACTICE.

At the siege of Strasburg the Prussians used for breaching purposes a short six-inch gun firing a special long shell weighing about sixty pounds. The method of breaching consisted in making a horizontal cut at a height from the bottom equal to one third of that of the wall; and when this cut was supposed to be satisfactorily effected, vertical cuts, if necessary, were made, the continued firing eventually bringing down the wall. The fact that the horizontal cut was satisfactorily completed could generally be decided by the sound of the concussion and explosion of the shell, by the nature of the fragments whirled into the air, and by the appearance of the smoke from the explosion of the projectile, it being, if delayed, of a dark-gray color, and slow in rising if the masonry had been broken through. One of the chief sources of strength of the fortress of Strasburg consists in the obstacles presented by different water ditches, and by the extensive inundations which can be formed in its vicinity. The French, by damming up the Ill and utilizing the sluices, had filled not only the ditches and the whole country opposite the south front, but had inundated a great part of the ground of the left flank of the attack. The plans of the fortress showed the besiegers that by the destruction of two particular sluices, the water upon the ground and in the ditches would be reduced to a very low level; but neither of the sluices could be seen from any part of the attacking lines. Neither did the inaccurate maps afford sufficient data by which to point the guns. It was known that the sluice was near a turret, and a certain turret was fired upon, until, by the firing, its exact distance was determined. Plotting this upon the chart, it was then found that this could not be in the neighborhood of the sluice. A second turret was fixed

upon, which, being also plotted upon the chart, was, it was evident, the right one. A number of shots were then fired at this turret in order to determine the point of mean impact, and by means of the necessary corrections it was possible to calculate the point of medium impact for the middle of the face of the turret; and thence by another transfer to compute the elevation and deflection for a point on the sluice just above the water-level in the ditch. A reference to the practice tables showed that at this range—a little over one mile—about eight or ten per cent. of the projectiles might hit the small sluice-gate at which they were aimed. An examination with a good glass showed, by the showers of water, wood, and stone, whether the sluice was hit or not. The bombardment continued with two guns, which were so pointed that two shots should strike on the face of the sluice about thirteen inches apart. After the fall of Strasburg it was seen that this sluice was very strongly built. Huge cut stones about six feet thick formed the faces of the water sluice-gates. The bombardment had nearly destroyed these gates, and had displaced or destroyed the stone-work, and the water in the ditches had been visibly lowered. Great attempts had been made by the French to repair the damages. —*Minutes of Royal Artillery Institution*, VIII., 143.

ROTATION OF RIFLED PROJECTILES.

In a recent paper by Captain Noble there are given the results of some investigations into the absolute values of pressures exerted by projectiles, in rifled cannon, against the spiral flange or groove by means of which rotation is given to the shot. This pressure, of course, depends on the angle of the rifling. In certain systems of rifling studs may have scarcely any work to do at the muzzle of the gun, while they may be severely strained at the commencement of the motion; by which means an unnecessarily severe strain is produced, tending to injure the gun. According to Captain Noble's investigations, guns should be rifled with an increasing twist. If rifled with a uniform twist, it is possible, as in a case quoted by him, that the pressure on the studs may amount to sixty-eight tons during the first six inches of the shot's movement, but have diminished to nine tons by the time the shot leaves the muzzle; whereas in the case of the accelerated parabolic

twist, as ordinarily constructed, the pressure varies from twenty-nine tons at the beginning to twenty-six tons at the muzzle. Among the other results at which he arrives, he states that in the ten-inch gun the pressure on the studs due to rifling is but a small fraction (about two and a quarter per cent.) of the pressure required to give translation to the shot, and that the increment of the gaseous pressure, or the pressure tending to burst the gun, due to rifling, is exceedingly small. Both in the case of the uniform and the parabolic rifling these theoretical results are entirely confirmed by the experiments of the Explosive Committee of the Ordnance Bureau, who have found no sensible difference of pressure in the ten-inch gun as fired in the rifled and unrifled state.—*Minutes of Royal Artillery Institution*, VIII., 367.

SILICATE COTTON.

Krupp, of Essen, the well-known cannon manufacturer of Germany, employs a preparation which, under the name of silicate cotton, he considers to be a most admirable non-conductor. It is made from blast-furnace slag, and is in the form of a spongy or cotton-like fibrous elastic substance, and is so light that one ton will cover five hundred and sixty square feet to a depth of two and a half inches. One of its advantages as a non-conducting covering for steam-boilers, heated pipes, etc., besides its absolute indestructibleness, is that it is very porous, and allows the ready passage of moisture, so as to show at once the existence and position of any leak. In application it is wrapped around the article, bound with wire, and covered with canvas.

The same substance under the name of "mineral wool" has been in use in the United States for similar purposes.—18 *A*, *Jan.* 7, 1876, 422.

LIGNOSE, A NEW EXPLOSIVE.

According to the *Industrie-Zeitung*, the new explosive, lignose, apparently woody fibre prepared with nitro-glycerine, invented by Trützschler-Falkenstein, is a very light powder, which in a loose condition burns very slowly. The cartridges made of it are larger than those of ordinary blasting-powder of the same power. As it does not withstand moisture, it can not replace dynamite. It has been employed in a num-

ber of mines, and the results of tests made of it, although not unfavorable, place its explosive force, which, however, does not seem to be uniform, at at least three times that of an equal weight of blasting-powder, instead of at five times, as claimed at first; the price has therefore been fixed by the manufacturer on the basis of the former, at something less than that of an equivalent quantity of powder. Great safety is stated as one of the advantages of its use, as it is said not to be exploded by contact with naked fire, and with difficulty by friction or percussion, while it can be used with a fuse in blasting. It is also said that but little, and that harmless gas, is left after explosion. In the *Polytechnisches-Centralblatt*, however, an account is given of an explosion and the destruction of the building in which cartridges of it were prepared by women, by stamping it into cases, although, according to tests made under governmental supervision, the occupation had been pronounced perfectly safe. The combustion of the cartridges, when first noticed, was so slow that twenty-two out of twenty-three persons employed escaped unhurt before the explosion occurred.—6 *C, September* 23, 1875, 375, *and* 13 *C, July* 1, 1875, 851.

INFLUENCE OF HEAT ON THE EXPLOSIVENESS OF NITRO-GLYCERINE.

Sergius Kern, of St. Petersburg, has been studying the effect of heat upon nitro-glycerine. The sample examined had a specific gravity of 1.6, and solidified at 4° Centigrade to a crystalline mass. At 187° it entered into ebullition, with separation of orange-colored vapors; at 220° it exploded strongly, at 262° more violently, and at 294° the explosion was very feeble, being accompanied by a yellowish flame. In other words, the explosive properties of the substance nearly vanished at a high temperature.—1 *A*, XXXIII., 153.

EXPERIMENTS WITH PRISMATIC GUNPOWDER.

In the course of some experiments made by the permanent Austrian Committee, it is noted that the Austrian prismatic powder has a smaller kernel and a less density than that ordinarily employed in Prussia for six-inch cannon; and the result of the experiments made with this powder shows that the maximum pressure exerted by it upon the common ball

amounts to 2520 atmospheres, being about 200 atmospheres, or 3000 pounds to the square inch, greater than the pressure developed by the Prussian prismatic powder.—*Mittheilungen Oesterr. Hydrogr. Bureau*, II., 13.

RESEARCHES ON EXPLOSIVES.

MM. Roux and Sarrau lately presented an interesting memoir to the French Academy, on certain phenomena presented by explosives. They find that two kinds of explosions can be manifested by the majority of explosive substances, according as they are made to deflagrate (explosion of the second order), or to detonate, as by the percussion of fulminating powder (explosion of the first order). They find, furthermore, that the energy of the explosion produced by the same quantity of the explosive is very different in the two cases, being invariably more powerful where detonation was employed as the inciting cause, as will be seen from an inspection of the following table, in which the explosive energy of gunpowder exploded in the ordinary manner is taken as unity:

	Explosive Force.	
Name of Explosive.	Second Order.	First Order.
Mercury fulminate	——	9.28
Gunpowder	1.00	4.34
Nitro-glycerine	4.80	10.13
Gun-cotton	3.00	6.46
Picric acid	2.04	5.50
Potassium picrate	1.82	5.31
Barium "	1.71	5.50
Strontium "	1.35	4.51
Lead "	1.55	5.94

Of these results, the most interesting and valuable is the fact that the detonative explosion of gunpowder, induced by the detonation of nitro-glycerine (which last is in turn detonated by fulminate), produces an explosive energy more than fourfold greater than that obtained by igniting powder in the usual manner.

STEAM FOG-WHISTLES.

It has been found by General Duane, of the United States Engineers, in his experiments made to determine the best form of boilers for steam fog signals, that as the steam used

is at a high pressure, and is drawn off at intervals, there is a constant tendency to foam and throw out water with the steam. To counteract this, a horizontal tubular boiler, like those used in locomotives, is recommended by him. The steam-dome must be very large, and surmounted by a steam-pipe twelve inches in diameter. The steam should be drawn off at a point ten feet above the water-level in the boiler. The diameter of the boiler whistle should be two thirds of its length, and the vertical distance of its lower edge above the coping for a steam pressure of fifty pounds should be from one third to one fourth of the diameter.—*Elliott's European Light-house System*, p. 25.

THE ELECTRIC LIGHT-HOUSE AT SOUTH FORELAND.

In the light-house at South Foreland the electric light is employed, and the electric current is generated by means of large magneto-electric machines, which are driven by belting connected with a steam-engine. Each machine is composed of 96 helices, mounted upon six gun-metal wheels, each of which carries 16 helices. Between these wheels are placed the magnets, eight in each division, 40 of which are composed of six layers or leaves riveted together, while the 16 end ones have but three leaves each. The magnets, which are mounted in frames, are stationary, while the helices revolve at the rate of 400 revolutions per minute. The power absorbed by the electric machine alone, including friction, is four indicated horse-power. The power of a magneto-electric machine is according to the gross attractive power of its magnets, each magnet having a certain lifting or attractive power expressed in pounds. In the machines at South Foreland each of the six-plate magnets will lift 108 pounds, and each of the three-plate magnets 54 pounds, making the attractive power of the magnets in one machine to be 5184 pounds. The proportion of the lifting power to the weight of a magnet is a good indication of its value, and, generally speaking, a magnet which will lift two and a half times its own weight is a good one. Each six-plate magnet at South Foreland has a weight of 43½ pounds, or two fifths of 108 pounds. The machines are connected by underground cables with the electric lamps placed in the lenses of the tower. The carbons used in the lamps are ten inches long by three

eighths of an inch square; they are regulated by an automatic apparatus, and consume at the rate of four inches per night for each lamp. The lenses are about the same size as ordinary third-order lenses.—9 *D, March* 6, 1875, 55.

THE USE OF GAS FOR LIGHT-HOUSES.

The great advantage of employing gas for light-house purposes is stated to consist in the fact that, by a very simple arrangement, the number of burners and the brilliancy of the flame can be increased from its ordinary to an extraordinary brightness, such as to provide for its visibility in all kinds of thick weather, except, of course, that condition of fog which no light, not even the sunlight, can penetrate. In a fixed-light apparatus, of any size, there is no occasion to alter the existing lenses if we wish to introduce the use of gas instead of oil; but in some lamps it may be necessary to provide for additional ventilation. The cost of gas-light is said to be less than that of oil, while the photometric value of the flame of gas is largely superior to that of any kind of oil. When the "fog-power" of the gas-light is turned on, the cost of the gas per hour is greater; but taking the average of a year's consumption, at several light-houses, it appears that there is an actual saving of about $300 per year by the use of gas. A very simple apparatus effects an automatic intermission in the light, which not only saves somewhat in the consumption of gas, but acts as a means of distinguishing one light-house from another, precisely as is at present brought about by the introduction of the flashing system. A gas-light of the first order, employing Mr. Wigham's gas-burners of 108 jets, would, if fixed, be equal to 70,000 standard candles; but, if revolving, be equal to 873,000 candles.—*Elliott's European Light-house System.*

THE ELECTRIC LIGHT FOR SIGNALING.

A series of experiments has lately been made at the celebrated Siemens-Halske Telegraph Works, in Berlin, with the object of testing the adaptability of the electric light for signaling purposes. The apparatus in question, which was operated from the roof of the factory, to the great astonishment of the populace, gave a light so powerful that ordinary writing could be read by its illumination at the distance of a

mile. It was arranged within a closed mirror in such a manner that the beam of light was projected against the clouds, which served as a screen. In front of the mirror the signals were made, which were duplicated upon the clouds on a gigantic scale. This process, it is said, is to be adopted by the German army for night-signaling.—6 *D*, XXXIII., 281.

FOG-SIGNALING BY EXPLOSIVES.

Major Maitland, of the Royal Gun Factory at Woolwich, recently delivered a very fully illustrated lecture before the Royal United Service Institution on fog-signaling by means of explosives; a lecture which was a continuation of a previous address by Vice-Admiral Collinson on the use of horns, whistles, the siren, etc., as fog-signals. Major Maitland states that three kinds of guns were experimented upon by the Trinity Board with regard to their appropriateness as signal guns; and that body decided to apply to the War Office for a solution of the following problem: "To produce the most far-reaching sound possible with a charge of three pounds of powder, and to enable two men to keep up the firing at intervals of not more than five minutes during a long-continued fog." The problem divides itself into two parts: the ease of working and the propulsion of sound. With regard to the latter and more difficult question, he states that the designing of a gun is a simple problem, but the production of sound is quite another matter. We have hitherto looked upon the noise of a discharge as a necessary evil; now, however, we have to investigate the cause of the report of the gun, and seek to construct such an apparatus as will give the greatest noise with the least possible expenditure of powder. The sound of a discharge is made up of two factors; one, the blow struck by the expanding gas on the still air at the muzzle of the gun; the other, the vibration of the metal of the gun. It is found that when a gun is fired, a great difference in the intensity of the sound is experienced by the observer, according to whether he places himself a little before or behind a line drawn at right angles across the muzzle of the gun. It would appear that the rapidly expanding gas strikes a violent blow on the air in front of the muzzle, and, failing to drive the mass of air at once, sends its vibrations forcibly

out on all sides. In order to catch the vibrations passing to one side of the muzzle and cause them to be propelled forward, it was proposed to enlarge the mouth of the gun into the form of a widespreading cup. It is not easy to ascertain precisely the distance in front of the muzzle at which the expanding gas strikes with the greatest force; but it is tolerably clear that when this point is once ascertained, it may be made the focus of a parabolic cup. A series of small experimental cannon with plain muzzles, conical and parabolic mouths, were then cast, and it was found that conical cups had a decided superiority over parabolic cup-shaped mouths. Experiments were also made on the comparative merits of gunpowder and gun-cotton, the experiments with the latter substance being carried out by Professor Abel; the result of which latter was that the gun-cotton, when exploded in the focus of the parabolic reflector, was decidedly superior to the effect of gun-cotton exploded in the open air, and in either case superior to that of gunpowder. A further series of experiments at long ranges, however, showed that while conical mouths, as above stated, are superior for short distances, the parabola gained the victory at long ranges. Experiments made on the kind of wad showed that a wooden block was superior to a junk wad; the latter, in its turn, being superior to the *papier-maché* wad. In conclusion, he stated that the experiments thus far made must be considered as only preliminary to those necessary in order to arrive at a full knowledge and definite conclusions on this important subject.—*Journal Royal United Service Inst.*, 1875, 481.

CARRIER-PIGEONS.

M. Laussedat communicates to the French Society for Aerial Navigation the result of some observations on the flights of carrier-pigeons. He states that he has been engaged in organizing a system of carriers for military purposes. Twelve pigeons were taken from Paris to Moulin, distance two hundred and seventy-one kilometers. The direct line from Moulin back to Paris being marked out for the use of the trained pigeons, they were observed to follow the mark very closely, and, according to a dispatch subsequently sent back to Laussedat, who remained at Moulin, it appears that seven of the pigeons arrived together

at their home in less than three hours, having accomplished the distance at an average of ninety kilometers per hour. Two arrived a little later, and the tenth stopped on the way. The atmospheric circumstances were, it is true, favorable; the wind was blowing from the south to the north, there were very few clouds, and the temperature quite moderate. The pigeons which accomplished this remarkable flight came from the Somme. In order to obtain a good race of carrier-pigeons, it is considered necessary to cross the Anvers with the Liège breeds. The City Council of Paris is about to offer a prizé for the best pigeons which are all of foreign breeds. A prize will perhaps also be offered for the best purely French breeds.—*La Aéronaute*, 1875, 248.

UNDERGROUND TELEGRAPH LINES.

A system of laying underground telegraph lines has been devised by Mr. A. Holtzman, of Amsterdam, Holland, which is said to have stood the test of two years' severe practice with most satisfactory results. His method consists substantially in having a trough, or gutter, of cast iron (or other material), which is filled with a peculiar bituminous insulating composition which the inventor calls *brai liquide*. The trough, or gutter, is placed at the bottom of a ditch dug in the earth, and the telegraph wires, covered with gutta-percha, are separately submerged in the composition; this done, a cover is fastened upon the trough and the ditch filled up with dirt. The composition soon solidifies, and retains the wires in excellent insulation, protecting them, at the same time, perfectly against moisture and decay. The system is also affirmed to be comparatively inexpensive. A line of some forty miles laid down upon this plan near Amsterdam, after two years of trial, is said to have proved itself completely successful, although laid in a bad and swampy soil.—6 *D*, XXXII., 307.

EXTINGUISHMENT OF CONFLAGRATIONS.

An elaborate paper has lately been presented to the Kansas City Academy of Sciences, and printed by its order, upon the "Prevention and Extinguishment of Conflagrations," by Mr. Theodore S. Case. In this he considers the various means of prevention, under the following heads: First, by

the exclusion of oxygen and atmospheric air; second, by fire-proof coatings of the combustible materials used in the construction of buildings; third, by rendering such materials themselves essentially incombustible; fourth, by rendering bedding, clothing, scenery of theatres, etc., incombustible; fifth, by mechanical obstructions, such as fire walls, shutters, etc.; sixth, by the avoidance of the causes of spontaneous combustion.

The extinguishment of fires is treated of under the following heads: First, by means of ordinary water; second, by means of water holding in solution gases which are non-supporters of combustion; third, by means of such gases applied directly to the flames by machinery; fourth, by means of gases and vapors generated by the heating or combustion of certain materials with which the timbers were coated or otherwise protected previously to the erection of the building.

These various methods are all taken up *seriatim* and discussed with much minuteness, and the whole paper is one that should receive the attention of insurance companies and other bodies interested in the preservation of property from fire.

SULPHUR AS A FIRE EXTINGUISHER.

A well-known French savant suggests in *Les Mondes* that brimstone should be carried on board every ship for use in case of fire. Half a hundred-weight of sulphur will be sufficient to abstract the whole of the oxygen from 3500 cubic feet of air, thus unfitting it to support combustion; and the writer remarks that in a closed space, like a ship's hold, the sulphurous gas produced by the burning of the sulphur will penetrate where water from the decks can not be brought to bear, while the density of the gas will prevent it from rising and spreading if pains be taken to properly close the hatches. The suggestion is offered that the brimstone be made up in the form of matches of considerable size, the ends of which can be passed through scuttles prepared for them in the decks or bulkheads.

The foregoing recalls an assertion that has emanated from several independent and trustworthy sources, namely, that the vapor of chloroform possesses to a remarkable de-

gree the power of extinguishing the flame of certain highly combustible substances, and especially that of burning petroleum. By pouring a small quantity of this substance upon such a burning mass of oil, it is affirmed that the flame will be at once extinguished, and that, furthermore, a small quantity added to petroleum notably reduces its tendency to ignite. No attempt, as far as we are aware, has yet been made to utilize this singular property.

EFFECTS OF TEMPERATURE ON THE ST. LOUIS BRIDGE.

In the construction of the great steel bridge at St. Louis, with its arches of 500 feet, calculations and allowances were made for expansion and contraction by heat and cold through a range of 140° Fahr., and the calculated difference in the elevation of the centre arch of the upper chord above the City Directrix on the hottest day of summer to the coldest day of winter was about 18 inches. Ever since the completion of the bridge, the height of the centre piers of the top chords of the arches above the City Directrix has been noted almost daily at temperatures which have ranged from 92° to 15° Fahr., and with the following results (the height is that of the centre pier of the top chord above the City Directrix):

Date.	Temp., 3 P.M.	Height in Feet.
May 6, 1874	69° Fahr.	63.548
June 29, 1874	77° Fahr.	63.688
July 20, 1874	91° Fahr.	63.757
Jan. 4, 1875	10° Fahr.	63.241
Jan. 9, 1875	15° Fahr.	63.065

Between the temperatures of the 20th of July (the hottest day of last summer) and the 9th of January (the coldest day of last winter) there is a difference of 106° Fahr., and a difference in height of 0.692 foot, or nearly $8\frac{5}{16}$ inches. The actual effect upon the structure, it will be observed from this statement, is much less than the calculated effect (which, for a variation of 107°, should have given a difference in height of nearly 14 inches). The difference is explained to be due partly to the protection afforded by the roof of the bridge, and partly to the fact that the iron-work is painted white, thus lessening the absorption of heat.—*Corresp. Railway World, Philadelphia.*

THE CONSTRUCTION OF REVOLVING DRAWBRIDGES.

Mr. Clemens Herschell has presented to the American Society of Civil Engineers a paper on the principles of the construction and calculation of the strains in revolving drawbridges, and his work has an important value as one of practical interest to the profession of engineers. The calculation of continuous girders was first undertaken by Navier in 1830, but was much improved upon by M. Classeyron in 1857. These and other authors have, however, Mr. Herschell states, developed only special cases, and he has undertaken to develop the equations for the general case of unequal spans and supports, either in or out of level. Following the equations given in a recent work of Weyranch, Mr. Herschell gives in detail the formulæ necessary to compute the dimensions of every part of the bridge in question, and illustrates the whole by numerical examples. The several equations are written out in full, and are so clear as to enable any one to follow the processes with ease. A couple of tables, showing the strains experienced by every portion of a bridge under certain loads, gives a very lucid view of the relative strength demanded in the various portions of the structure. —*Transactions American Society of Civil Engineers, March*, 1875, 395.

THE PROPER CONSTRUCTION OF SEWERS.

A report has lately been made by a committee of eight of the most eminent civil engineers and professors of Great Britain to the British Association for the Advancement of Science on the subject of the treatment and utilization of sewerage, which contains very valuable suggestions as to the proper construction of sewers. These suggestions are the more worthy of careful attention from the fact that not only are our city sewers at the present time badly constructed and of indifferent materials, but, in addition, there appears to prevail a mistaken and dangerous idea that it is better to build with loose joints, in order to allow of the percolation of the sewer contents through the subsoil. The importance of an intelligent and authoritative utterance upon these points is vastly more pressing at the present day than ever before, since the practice of connecting water-closets with

the sewers in the cities and larger towns has, of late, greatly increased. The following extract from the committee's report deals very fully with the subject in hand, while at the same time it manifests the gravity which the members attach to the matter: "The committee made a special investigation into the sewerage arrangements of the town of Cambridge, where water-closets are general, though not universal. The outlets of all the sewers were found to be under the level of the surface water in the River Cam, so that the sewerage is backed up into the sewers for a considerable distance, and the subsoil is constantly saturated with both water and sewerage in the lowest parts of the town. As many of the sewers are old and of irregular shape, much escape of the sewerage into the subsoil must take place. Inquiries were made into the state of some of the water-wells belonging to private houses, and it was found they were all contaminated by sewerage, owing to their proximity to the sewers in the streets and to the drains on the premises, so that the water can not be used for drinking, but only for washing. The chief general importance of the inquiry into the condition of Cambridge is the proof thus obtained of the contamination of wells, and therefore of subsoil, by the agency of pervious street or house sewers constructed in their vicinity; and the sub-committee gave expression to the conviction forced upon it in the course of its inquiries that all sewers, properly so called (that is to say, drains into which the refuse from human habitations is admitted), ought to be constructed of materials which are altogether impervious, and that a separate system of pervious drains, similar to agricultural drains, should be constructed where necessary to dry the subsoil. The sub-committee is of the opinion that the further construction of pervious sewers should be prohibited by Parliamentary enactment."

A NEW DRY-DOCK.

To meet the exigencies of an increasing coastwise and foreign commerce at the port of Philadelphia, a new dry-dock has lately been completed by the Messrs. Cramp & Sons, builders of the American line of steamships. The location of this structure, the want of which has of late been severely felt, is on the site of their present marine railway on the Delaware

front, foot of Palmer Street. The dimensions of the dock are 462 by 111 feet. It has required 4200 piles, and the basin is, of course, made water-tight by sheet piling. The pumping capacity, to be supplied with four centrifugal pumps, possesses an aggregate water-lifting power of 120,000 gallons a minute. The dock will accommodate ships of the largest size, being 100 feet longer than the ships of the American line.

THE EFFECTS OF LEVEES.

According to the Board of Commissioners on the reclamation of the alluvial basin of the Mississippi River, the idea is utterly without any good foundation, either in theory or experience, that the deposit made on the river banks must settle on the bottom, and that thus the effect of embanking a river is to confine its sedimentary matter to the channel, ultimately raising the bed, and with it the high-water mark. This idea is usually defended by appealing to the example of the Po, in Italy, which river is asserted to have raised its bed several feet. In point of fact, such is not the case. It has been shown in the most conclusive manner, by the great Italian hydraulic engineer, Lombardini, that there is no ground whatever for believing that levees ever produced the slightest elevation of the bed of the Po. The same truth is demonstrated by eighty years of observations upon the River Rhone, and by careful measurements upon the Mississippi. Another theory, diametrically opposed to this, is equally erroneous, at least as far as regards the Mississippi. It is asserted in the most confident manner that that river is flowing in a bed composed of its own deposit, with dimensions regulated in accordance with its own needs, and hence, with the increased velocity resulting from the confinement of its volume between levees, will rapidly excavate this bed to a corresponding greater depth, thus avoiding any permanent increase in its high-water mark. After reviewing various considerations, the committee state that we are to conclude that there is no mysterious agency which may be accepted as exerting a controlling influence upon the levee system; and by considering what experience has taught respecting the levees of the Mississippi during the past century and a half, it seems certain that the alluvial regions of that river can only be reclaimed

by levees. The vast crops of cotton, sugar, corn, and rice, with all the existing wealth represented by lands in cultivation, its villages, plantations, and stock, are the direct fruits of this method of protecting the country against overflow.

Nevertheless it is true that the practical application of the system is fatally defective, and that unless some radical improvement be made, no hope remains of opening to cultivation the immense districts of back lands now exposed to annual inundation by reason of annual breaks in the levees. The defects of the present system may be classified as due to erroneous organization of the levees, insufficient elevations, injudicious cross sections and poor construction, inadequate arrangements for inspecting and grading, and faulty locations of the embankments, which are often placed so near caving banks as to insure an early destruction. The plan recommended by the committee consists, first, in keeping open the Atchafalaya and the La Fourche, and, if practicable, the reopening of the Plaquemine. Second, in a general levee system extended from the head of the alluvial region to the Gulf, and including the valleys of the tributary streams. The country is divided into these natural drainage districts, each of which should have a responsible chief engineer, clothed with ample powers. Without some strong and simple organization, it is the deliberate opinion of this Commission that the alluvial region can never be securely protected against overflow.—*Rep. of Comm. of Engineers*, p. 31.

NEW HYDRAULIC CEMENT.

A French chemist has succeeded in producing a mineral composition which, it is claimed, surpasses hydraulic cement in its use as a mortar, and in its resistance to the action of water, while it is also said to be unaffected by air or acids, and to acquire a stony hardness at 230°, which it retains even in boiling water. It is prepared by subjecting a mixture of nineteen pounds of sulphur and forty-two pounds of pulverized stone-ware and glass to a gentle heat, sufficient to melt the sulphur, and stirring it until it forms a perfectly homogeneous mass. It is then run into vessels and allowed to cool. It melts at about 248°, and can, like asphaltum, be repeatedly used by heating it gently.—5 *C*, XXXVII., 295.

DUBOIS' PEINTURE HYDRAULIQUE.

At the recent French Maritime Exhibition, one of the most interesting exhibits consisted of several large iron plates, inclosed by cords and sealed by the Department of the *Ponts et Chaussées* as having remained under water, submerged in the sea, for a period of eight consecutive months. These plates are exhibited by M. Dubois, in order to show the qualities and merits of his *peinture hydraulique*—hydraulic paint—or anti-fouling composition, and, if accounts may be credited, they bear conclusive testimony to the excellent qualities of the composition. In one case, we learn, about half of the plate was left untreated, the other being duly coated with M. Dubois' preparation; with the two others, one half was coated as above with the hydraulic paint, while the other half was treated with the compositions of a similar kind most in vogue in France. In all three cases, our informant proceeds, the half of the plate treated with the Dubois preparation was found to be perfectly free from rust, as well as from all outgrowth or incrustation of weeds and shells; remaining, in fact, as clean and bare as on the day when it was immersed. The advantages claimed, and thus demonstrably established, for this anti-fouling composition are its cheapness, solidity, and durability, and the extremely valuable quality of preventing oxidation and the adherence of mollusks and sea-weed. These qualities, it would seem, should make the preparation admirably adapted as a protecting coating for iron and copper-sheathed ships.—*Iron Age*, VI., 451.

THE AQUOMETER.

A new steam-pump with the foregoing name was on exhibition at a late fair of the American Institute. In external appearance, as well as in construction, it bears a strong resemblance to the apparatus known as the Pulsometer, which is doubtless well known to our mechanical readers. The following description of the Aquometer will explain the principles of construction and action. There are two working chambers combined with an interposed pressure chamber. According to the position of a steam-valve, the steam enters one chamber or the other, and presses on the surface of the water in the chamber, forcing the same out. As soon as

the live steam reaches the discharge port, its free escape produces a reduction of pressure in the working chamber. The discharge-valve then closes, the steam-valve cuts off further entrance of steam, and the body of water in the central pressure chamber opens the suction-valve and causes an instantaneous condensation of the entire volume of steam in the working chamber, so as to produce a vacuum therein, the consequence of which is to fill the said chamber with water. The suction-valve then ceases, and the momentum acquired by the water flowing up the suction-pipe operates to fill the pressure chamber. As the one chamber is thus filling, the steam current operates to force the water out of the opposite chamber, so that a constant flow is kept up in the discharge pipe. The steam-valve is balanced, and means are provided to prevent injury by dirt or grit.—6 *D*, XXXIII., 273.

VERTICAL MOVEMENT OF VESSELS UNDER HIGH SPEED.

A well-known builder of fast steam-vessels, Mr. Thorneycroft, proves that at high rates of speed the body of a vessel actually rises above its normal load water-line, and as the speed is increased continues to rise still higher. This conclusion was reached from experiments conducted with a steel torpedo launch lately built for the Austrian government, and with which a speed of 19.4 knots was attained. The differences in level were determined by means of three plumb-bobs hanging from a bowsprit, at various distances in front of the bow, from observations with which the altered water surface was measured, and some very instructive diagrams made therefrom. From these it was shown that up to a speed of about 12 knots the vessel sank more deeply in the water, but on being driven to a higher speed she seemed to make an almost sudden leap upward, and continued gradually to rise above the normal water-line as the speed increased—6 *D*, XXXIII., 276.

INFLUENCE OF WIND ON PROJECTILES.

Since the introduction of rifled guns it has become a matter of importance to eliminate, as far as possible, every cause of incorrectness in artillery practice. One of the chief of these is the force of the wind; and Major Maitland, of the Royal Artillery, endeavors to supply the means of making

the requisite corrections, so that we may be able to foretell how much the range will be increased or diminished by the wind, and what allowance should be made in the direction of the projectile to the right or left. The results of Major Maitland's observations are of value to others besides military authorities, inasmuch as they give a means of determining the velocity of the wind at considerable elevations above the ground. The theoretical investigations given by him depend perhaps too much upon the assumption that the pressure of the wind against the projectile is inversely as the square of the velocity of the wind, according to the formula of Sweaton. But the actual observations quoted by him form an acceptable contribution to our knowledge on this subject. A wind whose velocity is estimated at twenty miles an hour produces, according to his observations, a deviation of thirty-eight feet in a range of two miles, the diameter of the projectile being six and a quarter inches.

THE BRAYTON READY MOTOR.

Mr. Brayton has lately brought before the public a gas-engine, in which sixty pounds' pressure may be generated within the space of one minute, and which can be started by the application of a match with almost the facility that gas may be lighted. In construction this new motor, which has lately figured in the proceedings and discussions of several of our Mechanics' Institutes, closely resembles the steam-engine; its cylinder and piston, valve-gear, and connections being essentially the same. The principal difference consists in the addition of a compressing-pump and a reservoir, for the purpose of compressing and of retaining a quantity of combustible gases, mixed with a proper proportion of air for its complete combustion, and at a pressure exceeding that which it is proposed to have exerted in the working cylinder. A "jacket" surrounds the cylinder, through which water is kept constantly circulating. The comparatively low temperature thus secured in the walls of the cylinder allows of the employment of the piston with packing rings which has become the standard for the steam-engine, and likewise of the same method of lubrication. A diaphragm similar to that which gives the Davy safety-lamp its security, and composed of several layers of wire-gauze, is placed at the opening

through which the gaseous mixture enters the cylinder. This is of more closely woven material than that used in the safety-lamp, and several thicknesses are employed, in order that it may act as an effectual preventive against the communication of ignition to the mass of gas inclosed in the reservoir. A similar diaphragm, but of much smaller area, allows a very small quantity of gas to stream continuously into the cylinder, and as this current is not interrupted by the closing of the induction-valve, its little jet burns constantly, and is always ready to ignite an entering charge. A safety-valve of large area is provided as a precaution against the possible accident of the flames reaching the reservoir.

The burning-gas employed and the air are taken in proper proportions into the compressing-pump, and from this are carried forward, intimately mixed, to the point at which the mixture is to do its work; by this means complete combustion is insured. In the machines of this type in operation at the time of this writing crude petroleum is employed in place of gaseous fuel, and the reservoir is filled simply with air which is carburetted at the point of combustion. It thus becomes possible to operate with but a very minute quantity of liquid in the apparatus at any one time, and an explosion is practically impossible from the fact that the explosive mixture is not formed until it arrives at the combustion chamber.

The induction-valve is protected from the action of the hot gases by the safety diaphragm which is interposed between it and the cylinder. Upon the opening of the induction-valve the mixed gases enter, and are promptly ignited by the constantly burning jet before described. The inventor of this ingenious mechanism claims that the operation of his engine is precisely similar in the action of the engine proper and in the distribution of pressure in its cylinder to that of the steam-engine; that the entering mixed gases burn steadily—not explosively—as they flow into the cylinder; and that the pressure from the commencement of the stroke to the point of cut-off, as proved by indicator diagrams, is as uniform as that observed in any steam-cylinder.

M. TECHNOLOGY.

RECENT PROGRESS IN PHOTOGRAPHY.

The success attending recent experiments in photography seems to justify the expectation of an early revolution in the manipulations of some of its fundamental processes. In the negative process, all the more vexatious and uncertain details have been in a great measure eliminated, and the practice of this branch of photography has been adapted to even the ordinary tourist. The collodion negative process, which displaced the daguerreotype process, about twenty-five years ago, as much by reason of its wider range of applications as because of its comparative simplicity and certainty, has remained essentially the same as when first introduced. Improvements in it have been mainly in the detail, and their adjustment to the various applications of which it was soon found susceptible. Its inconveniences, and the apparently needless complexity of its manipulations, were soon felt, and attempts made to remedy them; but the sensitive collodion film is still produced upon the glass plate by the professional photographer by charging it indirectly with the iodide and bromide of silver, sensitive to light. Some soluble iodides and bromides, insensitive to light, are first introduced into the collodion; and after a film of it has been formed upon the glass, it is rendered sensitive by immersing it in a solution of silver nitrate, where the insoluble haloid salts of silver form in the film, while the nitrates of the other bases, previously combined with the halogens, remain in the solution. But besides the complexity of the manipulations, the silver solution is expensive and voluminous, and requires expensive and fragile receptacles; and, withal, has generally been regarded as the most decided variable in the process, and, directly or indirectly, chargeable with most of its failures. In out-door photography, all the inconveniences and uncertainties attending the use of this solution are multiplied to such an extent that, failing in attempts to eliminate it altogether, the best effort, especially of amateurs, was directed to the improvement of the so-called dry processes, in which

plates, prepared up to the sensitive stage, are rendered capable of being kept in that condition by washing them thoroughly with water, then applying some preservative solution, as of tannin, gum, etc., and drying them. Although some of these processes in careful hands have been made to afford very satisfactory results, they are upon the whole inferior to the wet process in rapidity, certainty, and general excellence, in spite of the excessive care and labor required in the preparation and development of the plates. Another plan of relief from the silver solution, which naturally suggested itself at an early day, was the formation of the sensitive silver salts in the collodion, before pouring it upon the glass plate, by introducing into it the silver nitrate and the necessary iodides and bromides. But, after trial, this direct method was regarded for a long time as impracticable, mainly because the iodide and bromide of silver could not be made to form in a sufficiently finely divided condition to remain suspended in the collodion. At last, however, the so-called washed collodion emulsion process has been brought to such a degree of perfection that all the manipulations hitherto found necessary with the baths, washing-trays, preservative solutions, etc., seem to be reduced to the minimum of the one single, simple operation of pouring a sensitive emulsion of the haloid salts of silver with collodion upon the glass plate, and allowing the film to dry. All the articles required are already to be had in the market. The plates thus prepared are said to be of the best quality, of great certainty, and of absolute uniformity, equal in sensitiveness to those prepared by any dry process, and affording a fine film, free from granulation, even under the microscope, and, by regulation of the development, adapted to the production of negatives or positives, as may be desired. Besides the freedom from custom-house annoyances that this process guarantees to the tourist, it renders him at all times, as far as the size of his plates is concerned, entirely independent of the size of the receptacles for the various solutions. The first successful experiments in this direction were made by Bolton and Sayce, two amateurs of Liverpool, about ten years ago. They found that by omitting the iodide, an emulsion of bromide of silver with collodion could be formed, suitable for photographic processes. The conditions most favorable to

emulsification have since been most persistently investigated. The first difficulty in the process lay in the inability to introduce the silver nitrate and the bromide employed into the collodion in quantities exactly chemically equivalent; and if the silver nitrate happens to be in excess, fogging the negative results, unless some restraining mineral acid is introduced; while excess of the bromide reduces the sensitiveness of the film to a degree corresponding to that excess, and also exerts a solvent action on the invisible image, unless it is quickly developed. In practice it was found best, therefore, to employ a decided excess of bromide, and then to impart sensitiveness to the film, and prevent any solvent action on the image by washing out the soluble bromide with water. The soluble nitrate of the base, previously combined in the bromide, formed in the film in the operation, although of little consequence in the silver bath in the old process, would also tend to split the film on drying by its crystallization, if allowed to remain in it. All these difficulties were, finally, simply and effectually met by Mr. Bolton by washing out all the crystallizable salts from the emulsion, previously to the formation of a film with it on glass, while a preservative agent was added at the same time. An emulsion was prepared, with only such a degree of care as to the adjustment of the salts that it might give tolerable results, and was then poured into a large flat dish, and the film, when set, was washed several times with small quantities of distilled water, after having been divided into small squares with a silver fruit-knife, until all soluble matter was removed. The very light pellicle, formed by drying the film obtained in this way, contains all the essential ingredients for a sensitive emulsion, seems to keep indefinitely, and only requires simple solution in a mixture of equal parts of alcohol and ether, with the addition of a little alcoholic solution of tannin and of a saturated alcoholic solution of soap, to furnish an emulsion for the preparation of plates for present or future use. Such washed emulsion pellicle, in the form of shreds or powder, can be obtained by mail. The development of a plate is effected by wetting the surface with methylated alcohol and rinsing with water, then treating it with a weak solution of pyrogallic acid for about a minute, and then, whether a feeble picture be visible or not, pouring

off the solution into a very dilute solution of ammonia and bromide of cadmium and returning it to the plate, when a vigorous negative image will appear, formed of silver from the reduced bromide. Treatment with dilute nitric acid will convert this into a positive. Many modifications and improvements have been proposed, and are in course of trial. Stillman, in England, and Newton, in this country, have done much in this direction, while Mr. Carey Lea has shown that the presence of iodide of silver is not at all incompatible with a good working emulsion, and doubtless all compounds that were found valuable in the old processes will be found applicable in this. It is not unreasonable, also, to expect that it may be made equal in sensitiveness to the wet process. An emulsion of gelatin and the bromide, as first suggested by Dr. Maddox about the same time that the collodion emulsion was first formed, is far more sensitive than the latter. The removal of the soluble nitrates formed by washing was originated by Mr. King in connection with this process. He placed the gelatin solution, charged with the proper quantities of silver nitrate and potassium bromide, in a dialyser, by which all the crystallizable salts, added in excess or formed in the solution, were removed. The dialyser was found to be entirely unnecessary by Mr. Kennett, who simply poured the gelatin, mixed with the proper salts, into a flat dish, and placed the film in pure water, after it had set but not become dry, until all the crystallizable salts were extracted. The pellicle formed on drying this, cut into shreds, forms the basis of a very sensitive emulsion, and can be transported to all parts of the world in opaque packets. It simply requires the addition of warm water to fit it for use. It is, however, unsuitable for work in warm weather, and the emulsion is liable to putrefaction, so that it must be used soon after its preparation. In the multiplication of impressions upon paper, photographically, from the negative, perhaps no fact has been more annoying to the photographer than the decided liability of the prints to fade and deteriorate. And yet the silver-printing process retains its place almost universally. The carbon process affords equally beautiful and undoubtedly permanent pictures, and is more flexible in its character; but it does not seem, in any of its modifications, to have reached the simplicity and certainty re-

quired to entirely supplant the silver process, as it was hoped it would. A process recently proposed by Mr. Willis, however, is full of promise in this respect. In it the salts of platinum are employed, and the results are said to be equal in all respects to those obtained by the silver process, while a far shorter exposure to light is required. It rests upon the fact that ferric oxalate is reduced to ferrous oxalate by the action of light, and upon another fact, discovered by him, that ferrous oxalate is soluble in neutral potassium oxalate, and in this condition instantly precipitates metallic platinum from a solution of its chloride. When, therefore, paper that has been washed with a solution of ferric oxalate and platinic chloride is exposed under a negative to the light, ferrous oxalate is formed in proportion to the action of the light, producing a very feeble image. By drawing the paper then over a solution of potassium oxalate, the ferrous oxalate passes into solution, and reduces the platinum salt in contact with it to a degree corresponding to the action of the light, giving rise to a strong, rich, velvety-black picture, which is perfectly permanent under ordinary influence. The unchanged ferric oxalate is then removed by immersing the print in a weak solution of oxalic acid, and subsequently rinsing it well in pure water.

ETCHING PHOTOGRAPHS ON ZINC, IN RELIEF, FOR ORDINARY PRINTING.

Zinc plates that may be used with the ordinary printing-press may be prepared from ordinary photographic negatives, according to the following process given by Fichtner: A varnish, sensitive to light, is first made by dissolving five parts of Syrian asphaltum in ninety parts of benzol, and adding ten parts of oil of lavender, and then filtering. Much depends on the quality of the asphaltum, and only such pieces as do not melt at 234°, and dissolve with difficulty in oil of turpentine, should be selected. The benzol must be entirely freed by distillation from substances sensitive to light, and must also be entirely free from water. The oils also must be pure, and contain no water. A pure zinc plate coated with this varnish, and allowed to become perfectly dry in a dark room on a level surface, is exposed from twenty-five to thirty minutes in the sunlight under a negative which has been trans-

ferred to a gelatin film to prevent inversion of the prints. The invisible image thus formed is developed by pouring upon the plate petroleum, to which one fifth or one sixth its volume of benzol has been added, and keeping the plate in motion and renewing the solvent until the picture appears in the color of the varnish and the lights exhibit the clear metal. The plate is then washed under a stream of water to check the further action of the solvent, and allowed to dry in the light, when the varnish hardens, and acquires the power of resisting the acid employed in etching. The latter process is conducted as usual with dilute nitric acid until deep enough to allow the use of the plate with an ordinary printing-press. —13 *C, January* 1, 66.

NEW PHOTOLITHOGRAPHIC OR AUBELTYPE PROCESS.

It is said that an entirely new and very superior process for multiplying impressions from photographic negatives mechanically has been invented by Aubel, of Cologne, and has been named after him, in order to emphasize its entire independence of all previous processes for a like purpose. If it prove to be all that is claimed for it, it will doubtless increase the applications of photolithography. The use of organic substances, as gelatin and asphaltum, is altogether discarded, and no transferring agent is necessary, the photographic negative being so changed that it permits a transfer to be made to stone at any time in the simplest, cheapest, and most direct manner, with the preservation of all its excellences, while the subsequent lithographic manipulations remain as usual. Ordinary lithographic inks are used in printing, and the operation is much easier than with the usual transfers, since there is no difficulty in keeping open the finest as well as the heaviest hachuring. The stone can also be completely washed with turpentine without injuring the drawing, or affecting the finest tints in the subsequent printing. Among the most decided advantages of the process may be mentioned: 1st, the absence of all necessity for excessive nicety in its details, so that success in the preparation of plates is a rule, want of it the exception; 2d, the freedom from spreading or alteration of the lines of the original; 3d, the possibility of completing the preparation and transfer of a plate to stone in from half an hour to two hours;

4th, the unlimited number of impressions that may be made on any kind of lithographic press, and the avoidance of all necessity for the preservation of designs on stones, since a transfer can be made from the original plate at any time in a few minutes.—34 *C*, V.

THE GILLOTYPE.

A process known as the Gillotype, invented by M. Gillot, for producing printing-blocks by etching on zinc, has been lately introduced very extensively into use in Paris, where it is employed for the illustrations of newspapers and magazines. A paper is first prepared by covering India paper with one or two films of gelatin solution, applied very thinly and evenly, and allowed to dry; after which a coating of cold starch paste is put on, and subsequently a little gamboge dissolved in water. The picture is drawn in fatty ink upon the paper, and laid with its face downward upon the zinc, the surface of which must be well cleaned to remove all grease. A sheet of paper moistened with hydrochloric acid is placed upon it, and above this sheets of dry paper, and the whole passed two or three times through a lithographic press. The back of the paper containing the picture is then to be well moistened with water, which allows it to be removed from the zinc, leaving behind the fatty picture. The plate is then washed with a soft sponge, and subsequently with gum water, to which a little hydrochloric acid has been added, and the whole allowed to dry upon the metal. We now have an ordinary zincograph plate, from which an impression can be taken as from a lithographic stone; but for relief printing etching is required. A fatty or lithographic ink is applied to the plate and allowed to dry; and over the whole surface is then spread, by means of a tuft of cotton, some finely powdered rosin, which attaches to the greasy particles, and imparts to the ink a consistency sufficient to protect the covered parts from the action of the sun. The other portion between the lines and letters is freed from the powder by means of a second tuft of clean cotton, after which the borders and back of the plates are covered with shellac varnish. The plate is then introduced into the etching solution in a kind of trough, which is made to rock back and forward all the time, with the object of washing off continually any salt

formed by the acid. The precise details of the operator's manipulation must be managed according to the depth of the etching required. After the operation is alternated several times the plate is finally dried, and the white portions which have not been sufficiently acted upon are cut out with a narrow saw or with a graver, and the block is then ready for relief printing.—18 *A*, XXII., 319.

NEW METHOD OF MICRO-PHOTOGRAPHY FOR MAPS IN WAR TIME.

A system of micro-photography for maps in war time, and applicable also for the use of engineers and others who desire to carry a stock of maps and plans with them in a small compass, has lately been devised by Mr. Baden Pritchard, of the Royal Laboratory at Woolwich.

This method consists in reducing the maps, etc., to a moderate size, and photographing them on sheets of white gelatin. They are then tanned with alum, and washed with collodion and castor-oil. The maximum size of the map is six square inches. Fifty or sixty sheets can be pressed into a space of half an inch in thickness. Officers are instructed to have a collapsible dark chamber, into which, when not in use, the photographs can be slid. They can then be examined like transparent spectroscopic slides. It is proposed to adopt this arrangement at once for the service of the British army.—3 *A*, *June* 24, 1876, 808.

PHOTOGRAPHIC COPYING-PAPER FOR DRAWINGS, ETC.

A very simple French copying-paper affords copies in white lines on a blue ground of drawings pressed in contact with it by means of a glass plate, after ten minutes' exposure to sunlight. The pictures are then fixed by simply washing them in water. According to analyses by Professor Schwarz, the ground consists of Turnbull's blue, formed, doubtless, from the action of ferricyanide of potassium on ferrous oxalate, formed by the reduction of ferric oxalate by the light. He recommends for the preparation of a similar article floating paper on a mixture of 100 cubic centimeters of a solution of 31.7 grammes of red prussiate of potash in 500 cubic centimeters of water, with 300 cubic centimeters of a solution of ferric oxalate, prepared by saturating 9.45 grammes of crystallized oxalic acid with the precipitate formed by am-

monia from ferric chloride, and diluting it to 500 cubic centimeters. Exposure to the sunlight under a drawing for a quarter of an hour will afford an impression, which may be fixed by washing it in water.—14 *C*, CCXVIII., 62.

FRENCH METHOD IN ENGRAVING ON WOOD.

A French method in engraving on wood consists in first covering the block with a layer of gelatin (0.39 gramme to 31 grammes of water) by means of a soft brush. When this coating is dry it is covered, in the dark, with a solution prepared of (1) red prussiate of potash, 7.80 grammes; water, 62.20 grammes; (2) ammonio-citrate of iron, 9.10 grammes in 62.20 grammes of water. These solutions are mixed and filtered, and the mixture is kept in the dark. After the layer is dry it is exposed under a negative from ten to twelve minutes, and washed with a soft sponge, when a blue image appears. If thus prepared the coating does not shell off under the graver.—5 *A*, 1875, 98.

RETOUCHING VARNISH FOR NEGATIVES.

It is claimed that a film of the following varnish on negatives, as suggested by Monckhoven, can be retouched with a brush or lead-pencil three or four times as rapidly as one of gum: Add common shellac, in scales, to a saturated aqueous solution of carbonate of ammonia. After twenty-four hours pour off the clear liquid, add about an equal quantity of water, and bring the mixture slowly to boiling, while continually stirring it with a glass rod. A brown shellac solution is thus obtained, and there should be about one hundred parts of water to eight of shellac, and no odor of ammonia. The negative, after being washed, should be flowed with distilled water and allowed to drain, and should then be coated by flowing the varnish over it twice in succession. After drying, the coating is brilliant and hard, and insoluble in water. If many prints are desired, the retouched negative should be varnished as usual.—18 *C*, VI., 461.

PHOTOGRAPHIC POWER OF ARTIFICIAL LIGHT.

Comparative tests of the photographic effect of light from different artificial sources have been made by Riche and Bardy. Plates were sensitized with bromide of silver, and ex-

posed for sixty seconds at a distance of nineteen inches from the light, while screened from its action by ten unequal layers of waxed paper, the first four inches long, covering the whole plate, and each successive layer being one tenth shorter, the last being four tenths of an inch long. The effects were compared by noticing, after development, the number of layers of paper through which the light had acted. Thus it was found that the oxyhydric light penetrated but one layer; the Drummond light, three; that of zinc burned in oxygen, four; of the magnesium light, five; of a jet of nitric oxide passed through a flask containing bisulphide of carbon, six; of a jet of nitric oxide in a vessel of burning bisulphide of carbon, six and seven; of a jet of oxygen in a vessel of bisulphide of carbon, seven; of a jet of oxygen in a vessel of burning sulphur, eight. The introduction of oxygen into a jet of burning sulphur, as it produced the greatest effect upon the bromide of silver, seems to merit further tests as to its practical value.—19 *C*, VIII., 127.

FIRE-PROOF PAPER AND INK FOR VALUABLE DOCUMENTS, ETC.

The fire-proof writing-paper prepared, according to an English patent, of one part vegetable fibre, two parts asbestus, one tenth of a part borax, and two tenths of a part alum, can also be made of a heavier quality, suitable for binding books and preserving manuscripts, etc. The fire-proof ink may be used for printing as well as writing. It is composed of twenty-two drams finely powdered graphite, twelve grains copal varnish, two drams sulphate of iron, and eight drams tincture of gall-nuts and indigo carmine; all well mixed, and boiled in water. Any mineral pigment may be substituted for the graphite to form a colored ink.—9 *C*, XIII., 152.

IMITATION OF JACOBSEN'S COPYING-INK PENCILS.

Imitations of Jacobsen's substitute for ink, in the form of copying-ink pencils, have made their appearance. They consist essentially of the same ingredients as the original, namely, graphite and aniline color, but are consolidated simply by means of tragacanth or other mucilage, instead of by the peculiar process by which the compact, homogeneous mass of the original is formed. The imitation is, therefore, readily distinguished, since it is very porous and brittle, is never

pointed, and is generally carelessly finished. The pencils also absorb moisture from the air, and soon become soft and smeary.—6 *C*, 1875, 38.

PREPARATION OF COPYING-INK PENCILS.

According to Viedt, these pencils, or substitutes for ink, can be prepared by making a thick paste of elutriated graphite, finely powdered kaolin, and a very concentrated solution of violet-blue aniline, soluble in water (or of any other aniline color soluble in water), and pressing it, by means of a small press, into sticks about four inches long and 0.1 to 0.15 of an inch thick. When dry they are fit for immediate use. The proper proportions of the ingredients can easily be ascertained by trial; and perhaps gum arabic can be substituted for clay as a cement.—13 *C*, *July* 1, 849.

MARKING-INK UNAFFECTED BY CHLORINE.

An ink for marking linen, etc., which is proof against chlorine, may be prepared, according to Dr. Waltl, by dissolving eight ounces of extract of logwood in water, and adding half an ounce of yellow chromate of potash and a quarter of an ounce of chromate of copper, and evaporating the mass until it begins to thicken, and finally adding half an ounce of varnish.—26 *C*, XI., 14.

INERASIBLE BLACK INK.

A so-called inerasible ink is prepared by Gaffard, of Paris, of one part by weight of lampblack, twelve of potash waterglass, of the consistency of sirup, one of ammonia water, and thirty-eight of distilled water.—6 *C*, XI., 8.

COHAUSEN'S PERIGRAPH.

Tracing the profiles of architectural objects, by obtaining the co-ordinates of different points, rests so much upon the delicacy of touch and sight of the individual that the results are not accurate. A very simple instrument, devised by Cohausen and named a perigraph, eliminates this personal source of error by rendering the operation a purely mechanical one. It consists essentially of a lever, moving and sliding in such a way on a pivot, on a board covered with drawing-paper, that, when the board is held by the left hand from a ladder,

near to the object to be traced, and the one end of the lever is moved by the right hand so that the other end continually touches the object, a pencil fixed in the lever will trace a diminished profile of the object on paper. This can afterward be enlarged to the full size by means of the same instrument.—14 *C*, CCXVI., 204.

A PRINTER'S INK READILY REMOVABLE FROM WASTE PAPER.

The following process for the preparation of a printer's ink that can be far more readily removed from waste paper than ordinary printer's ink has been patented by Kirscher & Ebner. Iron is dissolved in some acid—sulphuric, hydrochloric, acetic, etc., will answer—and half of the solution is oxidized with nitric acid and added to the other half, and the oxide precipitated from the mixture by means of soda or potash. The precipitate is thoroughly washed and treated with equal parts of solutions of tannic and gallic acids, and the bluish-black or pure black pigment formed is thoroughly washed and dried and mixed with linseed-oil varnish, and can then be immediately used for printing from type, copper, wood, steel, or stone. Waste paper printed with it can be bleached by digesting it for twenty-four hours in a lukewarm bath of pure water and ten per cent. of caustic potash or soda, and then grinding it well in the rag-engine, and throwing the pulp upon cloth and allowing it to drain. It is then to be washed with pure water containing ten per cent. of hydrochloric, acetic, or oxalic acid, or of binoxalate of potassa, and allowed to digest for twenty-four hours, and may then be worked up into paper, or it can be dried, and used as a substitute in the manufacture of finer paper.—5 *C*, XXXIX., 1875, 312.

FOR TAKING TRACINGS.

The following process has lately been suggested: One part by volume of castor-oil should be dissolved in two or three volumes of alcohol, and this solution applied to the paper with a brush. The spirit soon evaporates, leaving the paper transparent and ready for use. A tracing in pencil may then readily be made, and when finished the paper is immersed in alcohol, which dissolves out the oil, restoring the sheet to its original condition. The drawing may afterward be completed in Indian ink or in colors.

COPYING APPARATUS OF BAUER & CO.

A copying apparatus, manufactured by Bauer & Co., of Vienna, consists of a metallic tablet framed in wood, and covered with a paste containing aniline violet, or red. By tracing with a pencil or style on paper laid upon this, enough of the material will be taken up by it to yield copies on moistened paper, by laying the latter on it and patting it with the hand. The results, however, are very limited in quantity and quality, since the paper is not strong enough to yield even fifty copies.—6 *C, January* 20, 1876, 28.

PAPIER-MACHÉ ORNAMENTS, ETC.

Some English *papier-maché* articles are remarkable not only for their form and general appearance, but also for their durability. They are manufactured by first pressing a sheet of very porous but strong paper, manufactured expressly for the purpose, upon the metal greased with tallow. This is then coated with good flour paste and a second sheet is laid on, and pressed and rubbed until it takes the form of the model and adheres firmly. The whole is then placed in a drying-chamber at about 104°, and then the operations of laying on and drying are repeated until the desired thickness is produced—twenty to forty sheets being frequently required for the purpose. The form is then removed, all the sides are carefully adjusted, and the article is then hardened by first immersing it in linseed-oil and purified wood-tar, and coating six to eight times with varnish, allowing it to dry thoroughly after each coat. It is finally ground down with pumice-stone, and ornamented with bronze, gold, or mother-of-pearl. Cheaper articles are manufactured from a species of paper pulp with certain proportions of white-lead, rosin, linseed-oil, and sugar of lead, carefully kneaded and rolled by the aid of steam. This is then pressed into moulds and dried. The most ordinary articles are made of pulp and earth colors, with the addition of some hardening cement.—5 *C*, L., 400.

PRESERVATION OF PLASTER CASTS.

Mr. John Bell communicates to the Society of Arts the statement that the thorough saturation of plaster in melted

paraffin will effectually preserve it from deterioration by the action of the weather. The paraffin, it is said, hardens the plaster so much that the finger-nail will scarcely scratch it, increases its weight considerably, gives it an appearance of transparency like ivory, and preserves it though subjected to repeated washings. The process of saturation is stated to be similar to that employed in the saturation of plaster casts in stearin.

IMPROVEMENT IN PLASTER OF PARIS.

A new process of manufacturing plaster of Paris is announced, which is said to afford excellent casts, that set slowly, and are of a pure white color. The process consists briefly in immersing the unburnt gypsum for fifteen minutes in water containing ten per cent. of sulphuric acid, after which it is calcined.

WATER-PROOF DRESSING FOR LEATHER.

A dressing for rendering leather water-proof, made as follows, as proposed by Hager, has been found to answer the purpose: Soften one part of India rubber in five parts of illuminating petroleum, by digestion for a day, and add twenty parts of paraffin to the pasty mass, and digest again for half a day, with repeated stirring, and then mix it with five parts of oil and five of tallow, and finally add ten of petroleum, or enough to give the mass the consistency of butter.—8 *C, February* 11, 1875, 55.

EFFECT OF FREEZING UPON THE COLOR OF FABRICS.

The reduction of the color of indigo blue on cotton by freezing, noticed by Köchlin, is ascribed by Goppelsröder to ozone in the air, which, he found by experiments, acts at temperatures below the freezing-point, if the material is not dry. He found that cochineal red on wool was decidedly weakened, but not bleached, after a week's exposure to ozone; aniline black remained unchanged; aniline brown on cotton became yellowish-orange; fuchsin, aniline blue and violet, corallin, and iodine green were bleached, as well as dyewood lakes, and even Turkey red. Ozone is also very effective in developing certain colors. This action is very decided in the case of aniline black, which is developed by

it in from one to one and a half hours. The Gramme machine is suggested for the production of ozone.—24 *C*, XV., 113.

WATER-PROOFING FABRICS WITH BICHROMATED GELATIN.

In cases where a certain degree of stiffness is not objectionable, as in the manufacture of canvas trunks, knapsacks, etc., and possibly also of roofing-paper, the material may be easily and cheaply rendered water-proof by simply stretching it in a frame, and coating it several times with a hot five to ten per cent. solution of gelatin, to which one part of bichromate of potash has been added in solution for every five of gelatin, and then exposing it to sunlight, or diffused daylight.—13 *C*, *December* 15, 1875, 1560.

DYEING PARCHMENT PAPER WITH ANILINE COLORS.

So-called vegetable parchment can, like silk and wool, be combined directly with aniline dye-stuffs without a mordant, and in this way a very durable material, of a variety of colors, may be prepared, suitable for book-bindings, fancy boxes, cases, etc.—5 *C*, XXXII., 1875, 256.

DISCHARGING ANILINE BLACK FROM FABRICS.

In order to discharge black from fabrics dyed with aniline black, Witz treats the portion with an acidified solution of permanganate of potash, whereby peroxide of manganese is precipitated in the fibres. A solution of oxalic acid is then used, which removes the peroxide, and leaves the parts of the cloth acted on perfectly white. It is suggested that a solution of the permanganate, thickened with infusorial earth, could be printed on fabrics, and thus discharge white figures on an aniline-black ground.—6 *C*, *January* 21, 1875, 29.

ARTIFICIAL ULTRAMARINE INDUSTRY.

The total production of artificial ultramarine during the year 1874 was 150,000 cwt., of the value of $3,000,000. The manufacture is chiefly confined to Germany and France, the former country exporting annually about 60,000 cwt. In addition to the greenish-blue, pure blue, and violet-blue shades, a violet ultramarine was among the exhibits of the Vienna Exposition. The composition and mode of prepara-

tion of this new product are as yet unknown.—*Manuf. Review*, VIII., 18.

PROHIBITION OF ARTIFICIAL ALIZARINE IN RUSSIA.

By a recently issued Imperial Ukase, the importation of artificial alizarine into the Russian Empire is prohibited. The purpose of this prohibition is said to be the protection of the cultivators of the Russian madder (marena), who for the last twenty years have been extensively engaged in its culture in the province of Daghestan. A few years ago the value of the crop was estimated to have an annual value of three millions of rubles, but it has now greatly fallen off. The aniline colors are, curiously enough, included under the prohibition—with the single exception of crystallized magenta—which is the one most extensively contaminated with arsenic.—*Manuf. Review*, VIII., 18.

GOLDEN-OLIVE ON CLOTH.

For two pieces of cloth—sixty-one pounds—dissolve four pounds of alum and two pounds of purified argol in a decoction of thirty pounds of fustic; add four pounds of turmeric and two pounds of orchil, turn the fabric in, boil for an hour, and then bring to the desired shade with sulphate of indigo, and further boiling.—23 *C*, *August* 27, 1875, 631.

DYEING SILK.

The following processes are recommended by Reimann's *Färber-Zeitung* for dyeing silk. First remove the gum, except from tram, best by moving the silk about, suspended on sticks, in a bath heated to boiling, containing one quarter of a pound of soap for each pound of silk; allow it to remain in this for twenty minutes, and repeat the operation in a bath containing one fifth of a pound of soap for each pound of silk. Tram must retain its gum, in order that the fabrics made with it may have the necessary stiffness and body; to prepare it for dyeing, place it, until its yellow color disappears, in a bath, at a temperature of 212°, prepared by mixing equal parts of sulphuric, hydrochloric, and nitric acids, and adding water enough to bring it up to 30° Baumé. For light shades then wash and bleach it; for dark shades the bleaching is unnecessary. Treat subsequently in the

same manner as ungummed silk. In dyeing brown, place the silk, before ungumming it, in a tin composition of 32° Baumé, rinse it, on removal from this, three times, ungum it, and dye in a fresh bath of alum, indigo carmine, fustic, and logwood, according to the shade desired.—24 *C*, XXXIII., 1875, 260.

BEAUTIFUL BLACK FOR STRAW HATS, ETC.

The following process, which is said to afford a beautiful and durable black on straw hats, can be readily applied, if desired, with but little trouble or loss of time by cloth dyers: The hats are first placed for several hours in a moderately strong soda or lye bath, and, after rinsing from it, are steeped overnight in an old sumac or gall bath. On removal from this, they are allowed to drain off well, and placed for two or three hours in a pyrolignate of iron bath. They are then exposed to the air for some time, when they almost blacken, and rinsed, and dyed up lukewarm with logwood, and drawn through a weak solution of glue, and dried and brushed.—5 *C*, XXXIX., 1875, 312.

DYEING BLACK WITH CERIUM SALTS.

Professor Böttger calls the attention of the Physical Society of Frankfort to the recent introduction of the bisulphate of cerium in dyeing, especially to the production with it, in connection with chloride of aniline, of an intense deep black on cotton yarns and fabrics. He found that by dipping the yarn several times, alternately, in a solution of chloride of aniline, slightly acidified with hydrochloric acid, and in a solution of bisulphate of cerium, and finally in a solution of bichromate of potash, it acquired a remarkably beautiful black color.—5 *C*, XXXVII., 1875, 295.

NEW BLACK FOR WOOL.

Wool dyed black according to the following recipe, it is said, does not rub off in the least, while the fibres remain loose and open, and it has a desirable reddish cast. Boil the thoroughly washed wool well for an hour and a half in a bath composed, for one hundred pounds of wool, of two and a half pounds of chromate of potash, two and a half pounds of alum, one half pound of blue vitriol, and two pounds of

commercial sulphuric acid, and dye it, without rinsing in fresh water, with twenty pounds of logwood and twenty pounds of Brazil-wood. It is advantageous for the color to allow the wool to remain in the mordant for twelve hours.—5 *C*, XXXII., 1875, 256.

XYLINDEIN, A NEW DYE-STUFF.

The name *xylindein* has been given to a green dye-stuff, examined by Fordos and Rommier, which results as a pathological effect of *Peziza æruginosa* in dyeing wood of the beech, oak, and birch, often to such an extent as to impart a dark blue-green appearance to large blocks. This coloring matter has been extracted from the green-colored wood, by Liebermann, with carbolic acid, and has been precipitated from the dark-green solution in dark-green flakes, by the addition of alcohol or ether. By recrystallization from the solution in carbolic acid it was obtained in small four-sided crystals, of a high coppery lustre. These are insoluble in most solvents, except in concentrated sulphuric acid, with a grass-green color, and in carbolic acid and aniline, with a beautiful dark-green color. No formula can as yet be given for it.—1 *C*, IV., 1875, 64.

EOSIN, A NEW FLUORESCENT DYE-STUFF.

A new dye-stuff has been introduced into the market under the name of *eosin*, by a German company. It is characterized, in solution or upon silk, by a beautiful fluorescence, combining in a most decided manner beautiful rose and reddish-brown tints. It consists of glistening greenish scales, readily soluble in water, and of an alkaline compound of a yellow dye-stuff, precipitable by acids. It seems related to the Bavarian phthalic acid dye-stuffs. Meister, of Zurich, employs it instead of litmus in the rapid titration of alkalies, since the disappearance of its beautiful rose color, upon acidification, is much more marked and sudden than the change of the blue of litmus.—8 *C*, *January* 7, 1875, 11.

A NEW ANILINE RED.

Dr. Isidor Walz has called attention to the discovery of a new coal-tar color which promises to become of importance. It yields shades exactly like those of cochineal, and almost

as fast. A sample of wool dyed with it was scarcely affected by a week's exposure to the sun. The discoverer is a New York chemist.—*Manuf. Review, N. Y.*

GEORGINE, A NEW YELLOW DYE.

A new yellow dye has been named Georgine, by Singer, of Tournay. It is said to be easily fixed upon all kinds of fibres, needing no mordant with silk and wool, but with cotton requiring previous treatment with alum, or passage through a cold or lukewarm sumac bath. For printing upon wool, cotton, or half-wool, it is thickened with gum water. It may also be employed to bring out the colors of turmeric, fustic, and picric acid, and affords mixed colors of remarkable purity, with other dye-stuffs.—26 *C*, XI., 14.

BARYTA-GREEN.

Böttger recommends the following mode for the preparation of baryta-green: Add gradually two parts of finely sifted peroxide of manganese to a mixture of two parts of caustic potash and one part of chlorate of potash in a state of fusion, and finally heat the mass to a low red heat. Allow it to cool, powder it, pour cold water over it, filter, and add to the green filtrate, in the cold, a solution of nitrate of baryta. Wash well with water the beautiful violet neutral manganate of baryta that separates, and when dry mix with it from one half to one part of hydrate of baryta, and heat the mixture at a low red heat, in a rather shallow brass or copper vessel, with continued stirring, until the contents, upon cooling, manifest a pure green color. Finally, pulverize it thoroughly, and treat repeatedly with cold water, in order to remove any hydrate of baryta present. — 20 *A*, *March* 27, 338.

DYEING COTTON PURE BLUE.

The following is suggested by Böttger for dyeing cotton a pure blue. Heat a mixture of 137 grains of Paris blue, 137 grains of tartaric acid, one half a fluid ounce of ammonia water, and two and a half fluid ounces of water, and filter, after cooling. Add to the deep blue filtrate a solution of caustic soda until it is decolorized, and after some time assumes a light yellow tint. Impregnate the cotton with this

solution, and pass it (best after allowing it to dry) through a warm, very dilute solution of sulphuric acid, and it will immediately assume a beautiful blue color, and needs only to be washed in water. The sulphuric acid may be so diluted that it has scarcely a perceptible sour taste.—5 *C*, XL., 32.

FIXING PRUSSIAN BLUE ON FABRICS.

Scheurer, of Berlin, recommends for a dark shade fifty parts of tartaric acid, one hundred and ninety parts of ammonia, one hundred and ten parts of dry powdered Prussian blue, and one hundred and fifty parts of water, with the employment of a gentle heat to hasten solution. In dyeing, the material is passed through this solution, and then, after drying, through an acid. For printing, an equal weight of thick tragacanth water is added to it, and the material, after printing and drying, is also passed through an acid. After the dyeing, or printing, a very deep violet color develops in drying, which immediately changes to blue on contact with the acid, and is almost completely fixed, remarkably little being lost in washing.—25 *C*, XXIV., 7.

FORMATION OF PURPURINE FROM ALIZARINE.

Lalande has succeeded in preparing purpurine from alizarine, which was perfectly free from the latter, after treating it with oxidizing agents under different conditions. One part of dry pulverized alizarine, and one of dry arsenic acid, or of peroxide of manganese, were added to eight to ten parts of concentrated sulphuric acid, and the temperature was gradually raised to 302° to 320°, until a drop of the mixture placed in slightly alkaline water produced the red coloration of purpurine. The mass was then treated with a large quantity of water and the precipitate washed with cold water, dissolved in a sufficient quantity of a saturated solution of alum, and re-precipitated by an acid. It was completely purified by treatment with alum again and crystallization out of superheated water.—5 *C*, XL., 23.

DOVE-COLOR ON RAW WOOL.

For one hundred pounds of wool, dissolve two pounds of alum and one pound of argol in a hot bath, and cool to 158°;

and, after the addition of a decoction of two pounds of logwood and five ounces of indigo carmine, enter the wool, and heat to boiling.—23 *C*, VII., 631.

VARNISH FOR BLACKBOARDS.

The following is the recipe, according to the patent of Formhals (which has expired), for a coating for blackboards: Alcohol, 95 per cent., 65 parts, or alcohol, 90 per cent., 67 parts; bleached shellac, 8 parts; Paris black, 8 parts; levigated pumice-stone, 4 parts; Paris blue, half a part; burnt umber, 4 parts; dryer, 8 parts. The pigments and pumice-stone are carefully mixed with alcohol, the shellac in solution being added last.—6 *C*, 1875, 18.

RENDERING OAK WOOD A BEAUTIFUL ORANGE-YELLOW.

Melt together, with continued stirring, one pint of oil of turpentine, and about 1200 grains of tallow, and 300 of wax. Rub the wood, in a warm room, with the mixture until a dead lustre is produced, and coat it an hour afterward with thin French polish. Greater brilliancy and a deeper tone may be produced by an additional coat of polish.—26 *C*, XI., 127.

BROWN STAIN FOR OAK.

Welger recommends the following as affording a cheap coating for wood, and which is very adherent, even when exposed to the weather: Brush the wood with a solution of persulphate of iron of 2° to 2½° Baumé. The bluish-gray tint it acquires on drying changes to an agreeable light-brown shade with linseed-oil varnish. A solution of protosulphate of iron will answer as well as one of persulphate. A dark brown shade may be imparted by subsequent coating with a half per cent. solution of permanganate of potash, and then with linseed-oil.—19 *C*, VIII., 26.

DEEP WALNUT STAIN FOR LIGHT WOODS.

The employment of alkaline manganates for staining light woods in furniture and floors a beautiful, uniform, and durable walnut brown is highly recommended by Viedt. The action depends upon the decomposition of the salt in the pores of the wood, with the separation in them of very finely

divided brown hydrated peroxide of manganese. In practice, addition of magnesium sulphate to the solution hastens the reaction. The process may be conducted as follows: Dissolve equal parts of manganate of soda and crystallized Epsom salt in twenty to thirty times the amount of water, at about 144°, and brush the planed wood with the solution. The less the water employed, the darker the stain, and the hotter the solution, the deeper it will penetrate. When thoroughly dry, and after the operation has been repeated, if necessary, the furniture is smoothed with oil, and finally polished. It is well to wash it carefully with hot water before smoothing, to prevent the efflorescence of the sulphate of soda formed. For floors the solution may be employed boiling hot, and if the stain is not dark enough, a second application of a less concentrated solution should be made. After it is quite dry, it should be varnished with a perfectly colorless oil varnish. On account of the depth of penetration of the stain, a fresh application will not soon be required. —25 *C*, XLII., 331.

GOLD VARNISH FOR METALS.

Dr. Kaylor found picric acid and boracic acid in a gold varnish for metals, which afforded a very hard and beautiful surface, and he recommends a clear solution of shellac, with the addition of picric acid, and about half of one per cent. of boracic acid, as giving results equally good.—8 *C*, XII., 311.

GILDING LETTERS AND DESIGNS ON GLASS.

According to Möser, the glass, after being thoroughly cleaned with powdered chalk, is coated uniformly, by means of a brush, with a hot solution formed by soaking seventy-five grains of gelatin in one quart of water, and then boiling it. The gold-leaf is next laid on very evenly, an operation requiring some practice. After this coating is dry, additional layers of gold-leaf are placed on it by means of the gelatin solution. False leaf may also be used for the purpose. The less uniform and heavy the leaf, the greater the number of layers required. When the gilding appears perfectly opaque, on being held up to the light, and has become quite dry, the letters or designs, previously traced with the point of a needle

if desired, are painted, reversed, upon it with black japan. If the layer of gold is too thin the varnish may be visible through it, and mar the effect. When the varnish is thoroughly dry, the excess of gilding is softened with water, and washed off, while the designs protected by it remain, and exhibit a very fine lustre, if the manipulation has been careful. Usually the whole glass is then blacked up with a dark oil-color, which renders the letters more distinct, protects them, and reduces the disturbing effect of reflection.—14 *C*, CCXVI., 184.

PURIFICATION OF FIXED VEGETABLE OILS.

Fixed vegetable oils are purified much more perfectly and cheaply than usual by a process practiced in England, in which the agitation of the oil, during purification, is accomplished by a current of air forced into it through a system of perforated tubes entering the bottom of the vessel, instead of by means of revolving paddles. The sulphuric acid is added to the oil, as usual, cautiously during the agitation, and on account of its more thorough contact with the oil effected by this method, the carbonization of the albuminous and other impurities is more complete. The acid is removed from the purified oil, as usual, and any residue of water by means of steam heat.—5 *C*, XL., 396.

OIL-PAINT FOR FLOORS.

None but earth-colors should be used in painting floors, and the rapid wearing off of a coating of oil-paint on a floor is a sure indication that white-lead has been mixed with the paint. This is generally the case, since it causes the paint to cover better and spread easier. Even the employment of a varnish that has been boiled with litharge should be avoided, and one boiled with borate of manganese preferred. It is also very important that the first coating should be perfectly dry before a second is laid on.—5 *C*, XL., 23.

PALMIERI'S DRAGOMETER.

Professor Palmieri has constructed an instrument which he calls a "dragometer." It is intended to determine the character of oils and textures by means of electricity. Among the properties claimed for it are: 1. It will show the quality

of olive-oil. 2. It will distinguish olive-oil from seed-oil. 3. It will indicate whether olive-oil, although of the best appearance, has been mixed with seed-oil. 4. It will show the quality of seed-oils. 5. Finally, it will indicate the presence of cotton in silken or woolen textures.—12 *A*, *Sept.* 9, 427.

UTILIZATION OF THE SUDS FROM THE WASHING OF WOOL.

In nothing has the advance of practical science been more clearly evidenced than in the extent to which substances formerly wasted and lost are now reclaimed and made to constitute an important element in the profits of the manufacturer. One of these applications consists in the recovery of the soap-suds from the washings of wool in woolen factories. These were formerly allowed to run down the sewers and into the streams, to the great pollution of the latter; but in Bradford, England, they are now run from the washing-bowls into vats, and there treated with sulphuric acid. The fats rise to the surface in a mass of grease a foot or more in thickness, which is carefully collected and treated in various ways, mostly by distillation. The products are grease, used for lubricating the cogs of driving-wheels in the mills; oleic acid, which is worth about $160 per ton, and used as a substitute for olive-oil; stearin, worth $400 per ton, etc. It is said that some large mill-owners are now paid from $2500 to $5000 a year for these suds, which a few years ago were allowed to run to waste.—18 *A*, XXI., 8.

STEEL BRUSHES FOR CLEANING IRON CASTINGS.

The removal of sand, etc., adhering from the moulds to iron castings, generally accomplished by filing, is said to be effected far better by means of steel brushes, placed in the market by Berthold, of Dresden. They are made of thin strips of steel, in the form of ordinary scrubbers, and also in that of whitewash brushes, and are reported to remain sharp for a long time, and to be far more convenient in use than the file. —9 *C*, XIII., 106.

APPARATINE, A SUBSTITUTE FOR GUM, STARCH, ETC.

Gerard has introduced a substitute for gum, starch, gelatin, etc., for finishing all kinds of fabrics of cotton, wool, or silk, and also for thickening in calico-printing, which he names

apparatine. It is said to afford very superior effects, and to impart a hitherto unattainable velvety surface, and to render transparent articles as stiff as metallic foil. It is prepared by stirring vigorously 16 parts of potato starch into 76 parts of water, and then adding, with continued stirring, 8 parts of potash or soda lye of 25°. After a few minutes the liquid clears up and forms a gelatinous mass, which is well beaten up, the quality of the apparatine being dependent on the amount of beating. It simply dries in the air without decomposition or spoiling, and without acquiring any odor, and may be formed into thin, transparent, colorless sheets resembling horn, but more flexible.—13 *C*, *May* 1, 1875, 576.

CLARIFYING AN ALCOHOLIC SOLUTION OF SHELLAC.

Peltz found that after shaking thoroughly one part of petroleum naphtha with three parts of an alcoholic solution of shellac, the liquid separated, on standing a few minutes, into an upper layer of naphtha containing the wax in the shellac, and a lower one of clear solution of shellac with but little adhering naphtha. With a solution of shellac in ninety-five per cent. alcohol the two layers will form, as above, only after the addition of water, so that alcohol below ninety per cent. is preferable to one above it for dissolving the shellac. A solution, clarified as above, however, leaves a more brittle and less adhesive film on evaporation. This defect may be remedied by the addition of one to three per cent. of Venetian turpentine. Benzine may be substituted for the petroleum naphtha with like results.—3 *B*, *March* 11, 369.

USES OF GELATINOUS HYDRATED PHOSPHATE OF LIME.

Dr. Saco has published a memoir upon the industrial applications of gelatinous hydrated phosphate of lime, which, according to his account, precipitates coloring matter, such as a decoction of powdered cochineal, in the condition of a lac; as also the metallic oxides—among others that of copper. Its affinity for coloring matter is, if any thing, even greater than that of albumen, which it can readily replace in various fabrics. For this preparation it is only necessary to introduce the tissue in a solution of phosphate of lime and a more or less dilute hydrochloric acid; then to wring out the cloths

and place them in an alkaline color bath.—3 *B*, XXXVI., 374.

SCHWEITZER'S SOLVENT FOR CELLULOSE.

Professor C. Neubauer recommends the following method for obtaining the well-known cupro-ammonium solution for technical use. He prepares an oxide of copper by the precipitation of sulphate of copper solution with caustic soda, in presence of sal ammoniac. The resulting precipitate is thoroughly washed with water, first by decantation and then upon a filter, after which it is preserved under water. To prepare the cupro-ammonium solution the oxide above referred to, after thorough agitation with the water, is slowly added to a quantity of ammonia contained in another vessel. The addition of oxide is to be continued so long as the same is dissolved by the ammonia. The resulting deep-blue colored solution dissolves cotton-wool at once, and in considerable quantity.—*Fresenius' Zeit. für Anal. Chem.*, XIV., 195.

OLEIC ACID AS A SOLVENT AND TEST FOR GUM COPAL.

A very small quantity of oleic acid dropped upon a sample of gum copal, and but gently warmed, will dissolve that gum completely. It is also an excellent reagent for distinguishing true amber from its imitation in copal.—9 *C*, XIII., 25.

ADULTERATION OF BEESWAX WITH PARAFFIN.

To detect this very common form of adulteration, Miller recommends that a small quantity of the suspected substance be tested to about 325° Fahr. with concentrated sulphuric acid, and upon cooling, the paraffin, if it be present, will be found upon the surface of the mixture.—*Fresenius' Zeit. für Anal. Chem.*, XIV., 200.

BLEACHED ISINGLASS.

On account of the preference shown by consumers generally for thin white isinglass, the inferior dark and bloody samples are bleached chemically at St. Petersburg, and sold as of first quality, although they have naturally a yellowish cast. According to Kattus, it has been established by experience that the bleaching impairs its adhesiveness and clarifying

power; and since the bleaching agent is never entirely removed, it may also very easily affect wine injuriously when used for clarifying it, and it may prove even more objectionable for medicinal and culinary purposes, although preferred to the natural isinglass on account of its color. Besides, only bleached isinglass can be adulterated with gelatin, and recently an impure article of this kind has been largely manufactured, which can scarcely be distinguished from the bleached and but slightly opalescent genuine article, while the Astrachan isinglass, even when soiled or dark and bloody, is fully as effective as the bleached. The chief characteristics of the genuine article are its freshness of appearance and peculiar opalescence.—5 *C*, XL., 214.

BLEACHING SPONGES.

Sponges are said to be bleached by the following process, without the emission of injurious or unpleasant gases: They are first covered with hydrochloric acid, for the removal of calcareous matter, and, after being washed with water, are immersed for five or ten minutes in a solution of one part of potassium or sodium permanganate to forty-five of water, in which they acquire a dark-brown color, which disappears on immersing them for one or two minutes in a solution of one part of oxalic acid in fifty parts of water, with the addition of a little sulphuric acid. They are then thoroughly washed with water. The brown color acquired may also be removed without injury by repeated immersions for several minutes in very dilute sulphuric acid.—13 *C*, *November* 1, 1867.

UTILIZATION OF CHROME-ALUM.

Although the chrome-alum occurring as a refuse product in the manufacture of certain coal-tar colors is reconverted in some cases, by Strohmeyer's process, into bichromate, in many cases it is entirely disregarded, owing to the tediousness and expensiveness of that method. A new way has recently been devised, which, it is claimed, does not require evaporation of the original refuse liquid, permits the almost complete recovery of the agent employed, and furnishes a liquid ready for immediate use. The product is said to amount to twenty-three and a half per cent. of the chrome-alum, so that the process may even be found profitable, aside from its use in

connection with the manufacture of aniline and alizarine.—8 *C*, XII., 254.

MODIFICATIONS OF CHROME-ALUM.

Gernez states, as the result of experiments, that solutions of chrome-alum which have been converted into the green modification by heating to 212° never crystallize, even if supersaturated, if care is taken that not a trace of violet chrome-alum or any other alum is present, and also that they retain their green color, and it is never assumed by solutions prepared cold. Upon slow evaporation a green transparent mass is left, which gradually fills with cracks. If, however, a fragment of crystallized chrome-alum, or other alum, is introduced into the above solution, crystallization instantly begins, and gradually violet chrome-alum crystallizes out.—15 *C*, XXX., 48.

REMOVING VEGETABLE SUBSTANCES FROM WOOL.

Messrs. Barral and Salvetat, in a memorial presented to the Academy of Sciences of Paris, refer to the fact that a large proportion of the wool imported from Australia and South America contains a greater or less percentage of vegetable matter mixed with it, which, of course, is injurious to its quality, and which usually resists the mechanical means of separation. An important problem, therefore, has been the destruction and elimination of the vegetable fibre by agencies that do not affect the wool. In summing up the results of their experiments, and considering those of others working in the same field, Barral and Salvetat remark that the cellulose and woody fibre can be decomposed under the action of several chemical agents, provided that the tissue, dried in the air after soaking, is then raised in a stove to a temperature of about 350° Fahr. These agencies are sulphuric acid, hydrochlorate of alumina, hydrochloric acid, nitric acid, chlorides of zinc, of iron, of tin, and of copper; nitrates of copper, of magnesia, and of iron; sulphates of tin and of alumina, etc.

PROCESS FOR COVERING COTTON WITH SILK.

A patent for effecting this object has been granted to A. Müller, the details of which are stated as follows: He makes

a solution of silk in hydrochloric acid (or ammoniacal solution of nickel or copper). The solution is filtered through sand, diluted until it begins to cloud, and the cotton (previously mordanted) is immersed in it for two or three minutes, then removed and washed. In this manner a silk-coated cotton fabric is produced.

NEW METHOD OF FULLING WOOLEN GOODS.

The following method, employed in Elbeuf, is said to require but a few hours, and to leave the wool very soft, while it does not attack the color. It consists in simply replacing the fuller's earth by suint. The latter is obtained as follows: A wooden vessel is filled with raw, unscoured wool, on which water is pumped from another vessel, and allowed to remain upon it three hours. It is then all pumped back into the second vessel, and again over the wool in the first vessel, and allowed to remain on it two hours. The operation is repeated several times, according to the quantity of suint in the wool, and the latter is then removed and thoroughly freed from water, and a fresh portion of wool introduced and treated in a similar manner, until the water is sufficiently saturated with suïnt, when it is drawn off and preserved for use. The cloth fulled with the necessary quantity of this liquid, in the machine, and then thoroughly washed, is said to be found perfect.

THE HAIR OF SQUIRRELS' TAILS FOR BRUSHES.

A useful hint in regard to the utilization of squirrels' tails was contained in the Chicago *Field*, in the form of an extract of a letter written by Mills Brothers, manufacturers of brushes, in Brooklyn, N. Y., to *The Commercial* of California. They state a fact which is perhaps known to few of our readers, that the so-called camels'-hair brushes are made from the hair of the tails of squirrels, the demand for which is increasing very rapidly. It is a question, however, whether the tails of the California squirrels—animals extremely destructive to the crops in California—will answer the purpose, as they are not true squirrels, but a spermaphile, or ground squirrel. The hairs on the tail of this animal, although long, are coarser than those of the tree squirrel, and probably less desirable. There would, however, be no difficulty in obtaining a suffi-

cient supply of the tree squirrels, such as the red, the gray, the fox squirrel, etc., throughout the various parts of the country, to meet a very large demand.—*Chicago Field*.

NUMBERING SILK THREAD AND FABRICS.

The system of numbering yarns by giving the number of meters in a gramme, agreed upon by the International Congress assembled at Vienna during the Exposition, is not satisfactory for silk threads, which are not, properly speaking, spun, but result rather from the simple combination of threads already formed. While the numbers of spun yarn may therefore be accurately expressed by the differences in length of a given weight of yarn, unvarying practice indicates that, for silk, it is preferable to employ the variations in weight of a given length of yarn, although the numbering on this plan begins with the finest instead of with the coarsest threads, as in the former case. Besides, the numbers for silk on the new plan would be inconveniently large. The original basis for the numeration of silk was the number of deniers (twenty-fourths of the old French pound) in 9600 ells; and afterward, on account of convenience and economy of time, the number of grains (twenty-fourths of a denier) in 400 ells, the name denier being retained; but it was found to vary greatly in different countries on account of the difference in the value of the grain; and even after changes in 1856 in France and Italy, the basis in France was 500 meters and 0.05311 gramme; in Italy and Switzerland, 450 meters and 0.050 gramme; and in Germany 476 meters and 0.05336 gramme. A basis of 500 meters and one half of a decigramme, suggested by the Chamber of Commerce of Crefield in 1874, was presented to the Congress at Brussels. While the exceptional character of silk in a system of numbering was recognized by that body, a desire was manifested to render the metrical character of its basis more apparent, and to give it a simpler relation to that of the others by making the units 1000 meters and one decigramme, in which case No. 1 of silk would correspond to 100,000, and No. 20 to 1000 of the other system. To this it was objected that, however desirable such a basis might seem theoretically, it was questionable on practicable grounds; since, from the nature of silk, it is impossible to produce threads of as great uniformity as

spun ones, differences as high as thirty-five per cent., and even higher, having been determined in a single thread of Asiatic silk, which differences are less manifest when long threads are taken, while the costliness of the material and the uniformity required in the woven fabric render it very desirable to the manufacturer to possess as accurate knowledge as possible of short lengths. Besides, comparison with the other system could readily be made by doubling the numbers in that suggested. The Congress, therefore, finally unanimously agreed, 1st, that the numbering of twisted and untwisted silk, as of other textile materials, should be based on metric and decimal measures and weights, with 1000 meters as the unit of length, and 1 decigramme as the unit of weight; 2d, that as the scale of numbering the variable weight of a uniform length shall be taken, and that 500 meters shall be weighed with a weight of 0.05 gramme as unit. These recommendations have been adopted at Lyons and Turin, and will doubtless be universally accepted.—*6 C, June* 3, 1875, 214.

CUIR-LIÈGE; A NEW FABRIC.

At the Maritime Exhibition held in Paris in September, 1875, M. Horeau exhibited for the first time a new fabric under the name of *cuir-liège*, or cork-leather, which is described as possessing quite a remarkable combination of new properties, adapting it to numerous applications as a substitute for products now in use. The mode of preparing the *cuir-liège* is as follows: Thin sheets, or pieces of cork, are covered on both sides with an extremely thin India-rubber skin, with any ordinary textile fabric outside of all, the whole becoming one quasi-homogeneous tissue; and although the cork sheets in their normal state are readily permeable by water, friable and brittle, and endowed with very little strength or cohesion, having only the positive qualities of lightness and non-conduction of heat, yet, when subjected to the treatment above described, the resulting product, *cuir-liège*, is extremely supple, endowed with great strength to resist tensile strain, and, while still retaining its comparative lightness and impenetrability to heat, it is rendered water-proof and impermeable to moisture. This new material may be crumpled up, rubbed and wrung like calico and linen in the wash,

doubled up any number of times and hammered with a mallet, without injury; the interior web of cork, which is the basis of the fabric, neither cracks nor tears in any way, but preserves its unity. With regard to its water-proof qualities, the articles on exhibition offered conclusive evidences. Boots, shoes, and other articles formed out of *cuir-liège* were shown swimming about upon water, without the water penetrating or in the least deteriorating them. To show the strength of the material, there is exhibited a weight of about half a ton suspended in the air by a strap, two inches wide and about an eighth of an inch thick, made of *cuir-liège*. The external appearance of the material varies according to the nature of the textile material used in combination with the cork; resembling leather, mackintosh, water-proof cloth, but endowed with far superior qualities. The product has, accordingly, already attracted the attention of government officials.

Among the uses for which the new material is claimed to be excellently adapted, combining a notable economy both in weight and cost, may be specified knapsacks, cartridge-boxes, cap-cases, pouches, straps, belts, and other articles of accoutrement, both naval and military; besides tents, awnings, etc., for ambulances and other purposes, in hot climates. Broadly speaking, it is affirmed that *cuir-liège* is a perfect substitute for leather in every case where leather is now used, and that it may be advantageously used in many cases where leather is not adapted.—*Iron*, VI., 426.

UTILIZATION OF LEATHER-WASTE.

Various methods have been proposed for the preparation of an artificial leather from leather parings and trimmings; but the products have had the disadvantage of being without elasticity and of coming to pieces in water. Sörensen, of Copenhagen, has lately patented an improved process for this work, in which the parings are first freed from impurities, and then worked by a special machine into a homogeneous mass. India rubber of any quality is then squeezed, washed, and cut in pieces, and dissolved in oil of turpentine, benzine, sulphide of carbon, or other suitable liquid. The leather is next treated with ammonia water, forming a gelatinous mass, and well stirred, after which the two masses are

united in a mixing-machine. In general, for sole leather, the composition consists of twenty-five parts of solid rubber with sixty-seven parts of the homogeneous mass of leather, and the whole pressed in moulds or rolled, after which it can be manipulated so as to be brought into any desired form.—18 *A*, *August* 11, 1876, 560.

A NEW INDUSTRY.

Among the novelties exhibited at the late fair of the American Institute were certain new products obtained from fir and pine tree leaves, which may ultimately set on foot a new industry. The following account of the invention will be found of interest: Mr. Charles Fulton has devised a process of treating the needles or acicular leaves of the fir and pine with certain chemical solvents, which results in the production of a substance resembling cotton, or perhaps more nearly wool, and having a dark, greenish-brown color. It is prepared of four qualities, adapted respectively for stuffing mattresses, pillows, etc., and for weaving. For the latter purpose, the fibres of the material are separated and treated in machines similar to fulling-mills. Another product of the invention is an excellent thread, which can be woven alone, or mixed with wool, cotton, silk, or other fibres. At the exhibition were samples of cloth, of a very fine texture, made from this thread. It is described as being soft and pliable, resembling a fair quality of flannel. Commenting upon this invention, our informant remarks that there is an enormous amount of raw material for this manufacture in the country, at present useless, which can be obtained simply at the cost of transportation, and which can thus be made available both for textile and paper industries.—6 *D*, XXXIII., 256.

NEW SUBSTITUTE FOR BARK IN TANNING.

The Western tannin plant (*Polygonum amphibium*), which grows luxuriantly in the Missouri River Valley, seems destined to replace oak-bark in tanning. It contains eighteen per cent. of tannin, while the best bark contains but twelve per cent., and large establishments employing it in Chicago find that one third more leather can be obtained with it than with a like quantity of bark. The process of tanning with

it is identical with that with bark, but the leather is tougher, finer, and more durable, and accepts a finer finish. The plant is an annual, and can be mowed, dried, and stacked like hay.—5 *C*, XL., 112.

RUSSIA LEATHER.

The best Russia leather (Juchten) exhibited at Vienna was that of Savin, of St. Petersburg, of which the following grades are employed in the manufacture of fancy articles: The Malia-Juchten, sold by the hundred-weight, rhomboidal in grain, and used for articles of more ordinary quality. Pared-Juchten, also sold by weight, generally rectangular in grain, is rather high in price, because it is reduced in weight by paring off the thick parts. It is used for fine articles, either smoothed or in its natural condition. Another grade, smoothed in Russia, and also sold by weight, is rendered still smoother and more highly polished by the Vienna manufacturers by moistening and rolling it, and forms the finest and most expensive article, much in demand of late for the so-called soft articles. Like the other grades, it is found of different sizes and weights. The Werhock-Juchten, named from the Russian superficial measure according to which it is sold, is a coarser grade, has beautiful clear pointed grain, is seldom smoothed, but is generally used in its natural condition for the larger articles.—34 *C*, I., 3.

OLIVE-OIL AND GLYCERINE AS A PARTIAL SUBSTITUTE FOR YOLK OF EGG IN TANNING.

It is proposed by Kathweiner, as a measure of economy, to substitute glycerine and olive-oil, in part, for the yolks of eggs in tanning. Thus in tanning, say, 100 skins, instead of 50 yolks, but 25 might be used, in connection with 4¼ fluid ounces of good olive-oil, and 3.4 fluid ounces of the strongest glycerine. The yolks should first be rubbed with a wooden pestle, and the oil and glycerine, previously mixed and well shaken, should be added in a thin stream with continued stirring. If the addition is not too rapid, an excellent emulsion will be formed by continued vigorous stirring for about four minutes. This should then be carefully mixed with the rest of the dressing, and be well absorbed by the hide. The article resembles in the whole process, and in its

final finish, that prepared entirely with eggs.—5 *C*, XXXVII., 295.

CEMENT FOR OVENS.

A cement for covering the joints of ovens that has been found excellent in practice and does not crack, but becomes very hard, may be made by mixing equal quantities of finely sifted wood-ashes and crushed and sifted clay, and adding some salt and sufficient water to form it into a dough, with which the cracks are coated when the oven is cold. If this cement is employed instead of clay in setting new ovens they will be almost indestructible.—26 *C*, XI., 15.

RAPID TANNING PROCESS.

Le Havre of the 23d ult. gives the following account of some interesting experiments which took place at Havre on that date in connection with the new and rapid tanning process: "A numerous concourse of merchants, brokers, manufacturers, etc., assembled at the Salle Saint-Cécilé to-day to witness some experiments in unhairing and tanning by the Montoison process. Dr. Limon, of Manchester, superintended the proceedings. A variety of skins were experimented on, from the fresh skin of a calf just killed to the old skins of sheep and goats burned and hardened by the sun of the tropics. There was, of course, some difference in the treatment of each kind, more time being required to unhair the dry, hard skin than that fresh from the abattoir. A short time was occupied in preparing the skins for the unhairing chemical by soaking them in hot water. Subsequently they received two coats of a pasty liquid on the inside, and were piled up, inside to inside, to undergo the action of the composition. Many questions were put in relation to the process, the reply to one of these being that the skin could bear the action of the composition for two entire days without being at all injured. After the skins had been soaked for a short time, the wool came from them absolutely intact, and quite equal to that shorn from the living animal. The manner in which the wool came away from the skin by a touch of the hand created considerable astonishment. In a few seconds the skins were dipped in two special baths to neutralize the unhairing composition. The afternoon was de-

voted to tanning experiments, which proved the invention to be a complete success. Many competent gentlemen did not hesitate in declaring their opinion that the rapidity of the process was little short of marvelous, and that the leather produced under it was to all appearance fully equal to that produced by the tedious methods now employed."—*Engineer*, XL., No. 1033, 263.

A NEW CEMENT.

The following recipe is asserted to produce a cement of very superior character for uniting stone and resisting the action of water. It becomes as hard as stone, is unchangeable in the air, and resists the action of acids. It is made by mixing together nineteen pounds of sulphur and forty-two pounds of pulverized stone-ware and glass. This mixture is exposed to gentle heat until the sulphur melts, when the mass is stirred until it has become thoroughly homogeneous, and is then run into moulds and permitted to cool. When required for use it is heated to 248° Fahr., at which temperature it melts, and may be employed in the usual manner. At 230° Fahr. it becomes as hard as stone, and preserves its solidity in boiling water.

ATTACHING LEATHER TO METAL.

A method of affixing leather to metal, so that it will split before it can be torn off, consists in digesting a quantity of nut-galls, reduced to powder, in eight parts of distilled water for six hours, and filtering it through a cloth; then dissolving one part by weight of glue in the same quantity of water, and allowing it to remain twenty-four hours. The leather is to be overlaid with the decoction of nut-gall, and the solution of glue applied to the metal, previously roughened and heated. The leather is then laid upon it, and dried under pressure.—4 *B*, V., 186.

MARINE GLUE.

An excellent marine glue, which can be melted at the same heat as common glue, can be applied with a brush, sets very quickly, is elastic and perfectly soluble in water, can be made by dissolving two ounces of India rubber in half a gallon of mineral naphtha. When the rubber is dissolved, add

twice the quantity of shellac to the naphtha, place the whole in an iron vessel, apply heat cautiously, stir till well mixed, and then pour out on a slab to cool.—18 *A*, XXII., 97.

DURABLE GLUE.

A very permanent and durable glue, which may be called chrome glue, is made by adding to a moderately concentrated solution of the glue one part of acid chromate of lime in solution to five parts of gelatin, this salt of chrome being thought better adapted to the purpose than bichromate of potash, which is usually used. The glue thus prepared, after being exposed to the light, becomes insoluble in water, in consequence of the partial reduction of the chromic acid. This preparation can be used in cementing glass objects liable to be exposed to boiling water, the treatment being the ordinary one of applying the glue to both surfaces of the fractured object, and then binding them together until dry, and exposing them for a sufficient length of time to the light, after which boiling water will have no action upon them. It is suggested that this preparation will be better adapted to cementing the covers on glass slides than any now in use. The same preparation can be applied for making fabrics water-proof, especially sails of ships, awnings, etc., where no great flexibility is necessary. Two or three applications of the glue, either by immersion of the object in it or by the use of a brush, will answer the purpose. Roofing-paper is also rendered impervious, even when exposed to long-continued rains.—13 *B*, *February* 6, 1876, 158.

WATER-PROOF AWNINGS.

Awnings can be rendered water-proof by plunging the fabrics into a solution containing twenty per cent. of soap, and afterward into another solution containing the same percentage of sulphate of copper. Wash, and the operation is finished.—*Engineer*, No. 1034, 281.

LIQUID GLUE.

Dilute officinal phosphoric acid with two parts by weight of water, and saturate with carbonate of ammonia; dilute the resulting liquid, which must still be somewhat acid, with another part of distilled water, warm it on a water-bath, and

dissolve in it sufficient Cologne or Flanders glue to form a thick, sirupy liquid. Neither glycerine nor sirup should be added, and it should be kept in well-closed bottles.—18 *C, February*, 1876, 95.

GELATIN AND BICHROMATE OF POTASH CEMENT FOR GLASS.

Dr. Schwarz has employed with success, for cementing broken glass-ware, a five to ten per cent. solution of gelatin, to which one part of bichromate of potash for each five parts of gelatin had been added, in solution. Both surfaces of fracture were coated, as uniformly as possible, with the freshly made solution, and held in position with a cord, and exposed to sunlight for several hours, after which the cement was not affected by hot water, and the fracture could scarcely be detected.—14 *C*, CCXVIII., 61.

COPPER ALLOY THAT WILL ADHERE TO GLASS.

The following alloy, it is said, will attach itself firmly to glass, porcelain, or metal: Twenty to thirty parts of finely pulverulent copper (prepared by precipitation or reduction with the battery) are made into a paste with oil of vitriol. To this seventy parts of mercury are added, and well triturated. The acid is then washed out with boiling water, and the compound allowed to cool. In ten or twelve hours it becomes sufficiently hard to receive a brilliant polish, and to scratch the surface of tin or gold. When heated it is plastic, but does not contract on cooling.—*Iron*, V., 683.

A NEW GLASS.

Following closely upon the public announcement of the results obtained by MM. De la Bastie and Peiper in the art of toughening glass comes the statement that Mr. Mackintosh, of Westminster, England, a civil engineer, who is represented to have devoted much time to the processes of tempering metals and alloys, has invented a method of hardening glass. From what has been published, it appears that Mr. Mackintosh, in his process, has started from his theory that the lower the temperature of the liquid bath in which certain heated bodies are plunged, the harder such bodies become. Mr. Mackintosh affirms, as the result of his observations, that glass, graphite, uncrystallized carbon, slag, and

analogous substances are rendered extremely hard when treated in the manner usually indicated for metals. The following is a brief description of the method adopted by the patentee: A quantity of the fused or nearly fused glass is first placed in iron or other moulds to shape the material; from these it is removed to moulds of platinum, in which it is reheated to partial or total fusion, and thereupon suddenly deprived of its heat by immersion in a mixture of iced water and salt, or other freezing mixture that produces extreme cold. The substance of the process consists, therefore, in heating the glass to a high temperature, and then rapidly cooling it in a very frigid fluid.—*American Builder*, XI., 188.

HARDENING GLASS, VULCAN GLASS, AND METALLIC GLASS.

The demand of Bastie for the secret of his process from the German Glass Manufacturers' Association was considered so exorbitant that it refused to treat with him further in regard to it, and purchased from Pelper, of Dresden, for $60,000, the process for the manufacture of the similar so-called Vulcan glass discovered by him. He was not ready, however, to communicate his process for several weeks, and, in the mean time, Lubische & Riederer, near Klitschdorff, succeeded in making a so-called metallic glass, which is said to be identical in character with that made by his process.—13 *C*, *May*, 1875, 573.

HARDENING GLASS.

It is said that a company has been formed at Bourg, in France, for manufacturing one of the new kinds of hardened glass, evidently that made by M. De la Bastie. The German glass-makers, not being able to purchase the invention of the French company, and having learned that hardness is given to glass by dipping the same, while it is heated to a half-liquid state, into a hermetically closed bath of oil or fat (substances which melt far below the boiling-point of water), have undertaken its manufacture. In Silesia, where repeated experiments have tested the qualities of De la Bastie's glass, another new glass has been invented by Lubische & Riederer, which is called metal glass, and is so hard that when a pane lies on the ground, and a leaden ball of an

ounce weight falls upon it from an elevation of twelve feet, it receives not the slightest impression.—12 *A*, XI., 474.

ARTIFICIAL GEMS OF HARDENED GLASS.

Mackintosh has patented a process for hardening glass, mainly for the manufacture of very hard artificial gems, by which he hopes to produce these superior to the diamond in hardness, and to furnish a glass powder superior to diamond dust and emery for grinding purposes. The process differs from that recently introduced for hardening glass, as the glass is cooled in platinum moulds, in a freezing mixture.—8 *C*, XII., 1875, 311.

WATER-GLASS FOR WASHING COTTON USED IN CLEANING MACHINERY.

According to the Hessische *Gewerbe-Blatt*, cotton that has been used for cleaning machinery may not only be completely cleansed by treatment with water-glass without affecting the fibre or color, but it is also rendered softer and more porous, and consequently preferable to new material, since it takes up oily matter more readily.—6 *C*, 1875, 29.

TINNING IRON TACKS.

According to Wiley, the process is to triturate chloride of zinc with a large quantity of oil, and heat it in an oscillating vessel, and, as soon as it has reached the proper temperature, throw in the tacks and the necessary quantity of metallic tin, and after a few seconds dip them out with wire gauze, and cast them into water.—5 *C*, XL., 104.

BRILLIANT ZINC COATING ON BRASS AND COPPER.

The following simple process is recommended by Böttger: Boil a large excess of so-called zinc dust some time with a concentrated solution of caustic soda, or potash, and place the copper or brass articles to be coated in the boiling liquid. By continuing the heating, after a few minutes a beautiful, mirror-like film of zinc will form upon them, by the decomposition of the alkaline solution, in consequence of their electro-negative character in combination with the zinc. It is suggested that the process is applicable to the preparation of disks for dry-piles, and also for forming a layer of tombac,

by heating a copper article thus coated carefully to about 248° to 284° (best under olive-oil), when the zinc will unite with the copper support to form a gold-tinted tombac, and the article need only be quickly cooled in water, or some other suitable liquid, as soon as the desired color is apparent. —18 *C*, VII., 345.

ENAMELING ON BRASS AND GERMAN SILVER.

The adhesion of enamel to brass and German silver, it is said, may be most perfectly effected by first engraving or pressing the design to be enameled into the alloy, and then coating the whole object, or only the depressed design, galvanically with copper. The enamel can be fused upon this surface as usual, and may then be bronzed or silvered, or treated in any usual way.—5 *C*, XL., 399.

BRONZING IRON CASTINGS.

A process for bronzing iron castings, patented in different countries by Gaudoin, Mignon, and Bouart, differs from preceding ones in dispensing with the intervention of a third substance, and at the same time rendering the film of copper so adherent that it will not scale off; but in some cases the iron and copper have been found to scale off together. The film is also said to be perfectly uniform in thickness upon the elevations and depressions, and on the undercut portions, and capable, in the hands of a skillful workman, of acquiring a close resemblance to bronze. The process has been employed at the large foundery of ornamental iron-work at Val d'Osne on castings of all sizes up to colossal statues, some of which have withstood the weather for a summer and two winters without the least injury. The cost is not more than double that by the usual process. A similar method may also be employed for tinning copper and cast-iron vessels.—5 *C*, XL., 383.

NICKEL-PLATING PROCESS.

Plazenet employs a bath composed of 87.5 grammes of sulphate of nickel, 20 grammes of sulphate of ammonia, 17.5 grammes of citric acid dissolved in 2 liters of water. Another recipe much used in France is formed of a solution of 4 parts

of nitrate of nickel in 4 of liquid ammonia and 150 of water, in which 50 parts of sulphate of soda have been dissolved. With a moderate current the operation is completed in a few minutes. When the film of nickel is of sufficient thickness the objects are withdrawn from the bath and dried with sawdust.—3 *A*, VI., 523.

PRODUCTION OF A BROWNISH PATINA ON ZINC.

A solution of molybdic acid, or of molybdate of ammonia, in very dilute aqua regia, or of molybdic acid in excess of very dilute solution of caustic soda, according to Professor Kletzinsky, produces a very pleasing, adherent, brownish patina, inclining to iridescence, upon articles of cast zinc immersed in it.—13 *C*, 1875, 1555.

COATING MIRRORS WITH AN ALLOY OF GOLD AND PLATINUM.

Five hundred grains of spongy platinum are dissolved in 50 cubic centimeters of hydrochloric and 50 of nitric acid, and the mass is evaporated to dryness. It is then powdered and digested with 2000 grains of essence of lavender, 100 grains of turpentine, and 25 grains of sulphuretted turpentine resin (*baume de Soufre terebenthine*). Thirty grains of gold, made into chloride, are dissolved in 500 cubic centimeters of water and an equal amount of ether. The liquid is shaken, and the ethereal solution added to the platinum and allowed to evaporate spontaneously. Fifty grains of litharge, fifty grains of lead borate, and 100 grains of lavender-oil are then added, and the mixture is shaken, after which the mirror is coated with it, and kept at a red heat until the composition is burned in.—21 *A*, XI., 928.

NICKEL-PLATING SOLUTION.

Hesz prepares a nickel-plating solution that yields beautiful results, by mixing the liquid obtained by evaporating a solution of one-half ounce of nickel in aqua regia to a pasty mass, and dissolving it in one pound of aqua ammonia, with that obtained by treating the same quantity of nickel with a solution of two ounces of cyanide of potassium in a pound of water. More cyanide of potassium renders the deposit whiter, and more ammonia renders it grayer.—18 *C*, VI., 185.

REFLECTOR FOR MOULDERS.

A novelty of this kind has lately been invented, the object of which is to do away with the inconvenience often suffered by moulders in being compelled to pour off metal in the imperfect light of winter, or during obscure days, and which often causes serious losses and delays.

The device in question involves no extra cost for illumination, and consists simply of a concave disk of metal, nickel-plated to secure good reflecting qualities, which is placed upon the ladle handle, and throws a strong light from the molten metal directly over the edge of the ladle into the sprue-hole. The moulder is thus enabled to pour the metal into the flask with great certainty.—*Iron Age, October* 21, 7.

SELF-FEEDING NAIL-MACHINE.

A machine of this description, the invention of F. A. Gleason, of Brooklyn, is in operation at the nail factory of the Albany Iron Works. The machine is making sixpenny nails at the rate of 200 to 300 per minute, and but one attendant is needed for five or six of the machines. The feeding device, which is its chief novelty, consists of, first, a plate-box, holding a thirty-pound plate. The lower plate is discharged immediately after the first plate has been cut up; second, an automatic nipper, which seizes the plate, carrying it down to the cutters and feeding it until consumed, then returning and discharging the scrap in a receptacle provided for that purpose. The feeding process is quite simple, and the only parts liable to friction and constant wear are an eccentric, elbow, and their connections. The machine runs rapidly, and becomes very hot; but this defect, it is believed, can easily be remedied.—*Bullet. Am. Iron and Steel Assoc.*, IX., 281.

FLEXIBLE MANDRIL FOR BENDING METAL PIPES.

At a recent meeting of the Franklin Institute the following ingenious device for the above purpose was exhibited. The mandril consists of a coiled or spiral spring, made of square steel wire, and of such size as to be freely inserted into the pipe to be bent. The pressure may then be applied in any convenient manner, but preferably it should be done

with a block of wood shaped to the curve to which it is desired to bend the pipe, its edge being grooved to fit the outside of the pipe. After the bend is made the mandril can readily be withdrawn by turning it from one end in the direction in which it is wound, which action slightly reduces its diameter, and by this means it is *screwed out* very easily. The old method of bending pipes of copper or brass is to fill them first with rosin, lead, or sand, and requires considerable skill, being both tedious and uncertain, especially for large pipes; and the crimping of the inner sides and stretching of the outer sides are very unequal, the pipe always requiring to be hammered and filed into shape at the conclusion of the bending. The new method, besides requiring much less skill and scarcely one twentieth of the time of the old, obviates all the above-named objections, leaving the pipe so near perfectly round that the eye does not detect the variation, and its surface so smooth as not to necessitate filing.—1 *D*, LXX., 22.

TEMPERED STEEL BRUSHES.

A recent novelty in the metal trade has been introduced by a French manufacturer, in the shape of brushes made of tempered steel wire. These implements, according as they are intended for various uses—cleaning tubes, or the sheathing of ships, iron bridges, sluice-gates, and iron construction generally—are of different forms. They are also made, like the old metallic brushes, for polishing or scratching metals, for stone and marble, for smoothing flooring and the decks of ships, and for many other purposes. The same maker has produced a new scraper for the special purpose of cleaning locomotive boilers. This special device is a spiral brush, in which, however, the steel wire is replaced by pieces of steel spring, and is said to be not only very effective, but also very durable.—*Iron Age, September* 2, 1875, 1.

RAPIDITY OF FILTRATION.

Dr. Fleitmann has called attention to the fact not generally known that, contrary to what at first sight might be expected, filtration is much more rapid through thick paper than through thin, and that it is almost twice as rapid through a double filter as through a single one, and still more rapid

through a triple one. He says that he has taken advantage of this fact for a number of years by employing in quantitative analyses a filter of heavy paper beneath the thin one of Swedish paper.—15 *C*, XXX., 170.

NEW APPLICATION OF INFUSORIAL EARTH.

Böttger publishes the observation that when an alcoholic solution of any of the coal-tar colors is mixed with a sufficient quantity of infusorial earth, water added, and the mixture filtered, the liquid will run off clear, while the earth retains all the pigment. Hitherto the compounds of alumina have been used for the production of the so-called lakes, and it is quite probable that the above-noted behavior of this material, which is very cheap, may find important applications in the arts.

CONDENSING BEER FOR PRESERVATION.

A patent for condensed beer has been taken out by Mr. Lockwood. The liquid may be taken at any stage of fermentation, although it is thought best to treat it when fit for drinking. It is evaporated in a vacuum until a large part of the water and alcohol is distilled away, and the beer is reduced to a thick, viscid fluid of about the consistency of molasses. The alcohol and water pass off in vapor, which is condensed, and the alcohol subsequently obtained by redistillation is mixed with the condensed beer, either before bottling or at any time afterward. In this way beer may be reduced to one eighth or one twelfth its original bulk, and it is said to keep for any length of time. To restore the beer to its first consistency, it is only necessary to add the bulk of water distilled off, with a small quantity of yeast or other ferment, and in forty-eight hours the beer will be ready for bottling. If charged with carbonic acid in a siphon-bottle or receiver, the necessity of renewing the fermentation is obviated.—18 *A*, XXII., 397.

NEW FORM OF PAPER FILTER.

Professor Stolba states that he has employed the following form of paper filter for a long time in analytical determinations, as well as for other purposes. He recommends it, principally, on account of the comparatively small amount

of ash, where small quantities are to be determined, since but little more than half as much paper is employed. Although less water is used for washing, the filtration is somewhat slower, since it does not fit the walls of the funnel so closely. The paper is simply folded once in the middle, and the one end then closed by a sharp narrow fold, formed by lapping the paper several times, each time rubbing the fold with a paper-knife or agate pestle. It is then rounded, like an ordinary filter, placed in the funnel dry, and moistened, and the fold pressed against the funnel with a glass rod. He suggests that other materials besides paper might be used, and that collodion, or some other cement, might be used instead of the repeated folding.—14 *C*, CCXVI., 445.

ANOTHER DIRECT SODA PROCESS.

Herr Viedt has ventured the opinion that common salt may be converted into caustic soda by the simple action of steam at high temperatures. The chemical changes involved in the process would be simply the production of caustic soda and hydrochloric acid, which last, being gaseous, could readily be removed. The experiments he has undertaken upon this subject have, however, only met with partial success, possibly because of imperfect apparatus. Should his expectations be realized in future experiments, a material advance in the alkali manufacture would result.

PREPARATION OF BLOOD AS A POWDER.

Mr. Le Bon says if blood be evaporated under diminished pressure at the temperature of the body, in a certain apparatus, it will be obtained as a powder soluble in water or in an acid solution of pepsin, and showing the characteristic absorption-bands of hæmoglobin, which constitutes eighty-six per cent. of the corpuscles. This method is suggested by the author for the utilization of the blood for food or for other purposes.—21 *A*, *February*, 280.

AIR-TIGHT JOINTS.

Professor Crookes states that in some observations made by him it has been necessary to preserve his apparatus within a vacuum for a number of hours, and, if possible, days. To this end it was very important to secure a cement that would

unite the joints of his apparatus in such a way as not to allow the leakage of air under an ordinary pressure of ten to fifteen pounds to the square inch. Whenever possible, glass tubes should be united at the joints by fusion, and when this is impossible mercury joints should be used, and it is found that the best way to construct these is to have a well-made perforated conical stopper of very pure India rubber let into the wide funnel tube of the joint and carrying the narrow tube. Before fitting the tubes into the India rubber, this is heated in a spirit-lamp until its surface is decomposed. It is then fitted into its place, mercury poured over, and oil of vitriol on the top of that, and when well made this joint seems entirely secure. Ordinary India-rubber joints are of no use in these experiments, as when the vacuum is nearly perfect they allow oxygenized air to pass through as readily as the pump will remove it. A cement that lasts satisfactorily for a few hours, but not over a day or two, is made by a mixture of eight parts of resin and three of beeswax. —7 *A*, XLVIII., 86.

TO PREVENT SHAFTING ACCIDENTS.

Many suggestions have from time to time appeared upon the subject of preventing or lessening the liability to accidents arising from the entanglement of some portion of an operative's garments in a swiftly revolving shaft, which accidents are of too frequent occurrence in our large manufactories, and are of a distressing or fatal character. One of the simplest methods of rendering these casualties impossible, without introducing the necessity of constructing a railing or fender about the moving piece in dangerous places, is to cover the shaft with a loose sleeve along its entire length. This may be made of sheet-tin or zinc, and to be removable if desired. It should be covered within and at the ends with leather, to prevent noise. Arranged in this manner, the friction between it and the revolving shaft would be sufficient to cause the sleeve to rotate with the latter; but in the event of any decided resistance being brought to bear upon it, as in the case of the engagement of a workman's garment, the sleeve would at once be brought to rest, and permit of its extrication without accident. The same ideas of loose covers may be applied to cog-wheels or

pulleys, and prove an invaluable protection against loss of life or injury to the person.—6 *D*, XXXIII., 69.

THE INDUSTRIAL EMPLOYMENT OF THE LIGHT PRODUCTS OF PETROLEUM.

We have taken the opportunity in these pages, when upon the subject of petroleum and its products, to dwell upon the desirability of the discovery and general introduction of industrial processes by which the lighter products of the refinery—gasoline and the naphthas—would be withdrawn from their present frequently dangerous, reprehensible, and illegal uses, and their admirable lighting and heating qualities utilized in a manner consistent with common-sense and the safety of life and property. One of the most natural and promising directions in which to look for this consummation is to be found in the efforts of inventors to convert these valuable but troublesome products into permanent illuminating gases, in which condition their consumption is attended with no danger.

CARRÉ'S CARAFE ICE-MACHINE.

M. Carré, whose name is well known in connection with the invention of several forms of ice-machines, has lately added to his achievements in this field by designing another contrivance for the same purpose, which, for effectiveness, simplicity, and general utility, if accounts may be credited, bids fair to surpass every thing of this kind that has yet been produced. The new machine can be easily operated by even an inexperienced person after one or two trials, and may be properly designated as a "family ice-machine."

The essential parts of the apparatus consist of an air-pump, capable of producing a good vacuum, a horizontal cylindrical receiver, partially filled with sulphuric acid, and the carafe or flask, in which the water is frozen, and which is connected with the receiver (and consequently with the pump) by a suitable pipe or tube provided with a necessary stop-cock. The carafe is suspended from the tube by means of an India-rubber ring, which insures an air-tight joint between it and the receiver. The operation of the apparatus is as follows: The carafe, an ordinary flask with elongated neck and swelled body, is half filled with water, and suspended from the table

before mentioned by means of the rubber ring or cork. In order to insure the perfect tightness of the joint between the flask and the tube, upon which the success of the operation of freezing is largely dependent, the stop-cock upon the tube is closed, a small quantity of water is poured between the cork and rim of the glass (to render any subsequent leakage visible), a few strokes of the pump are made to exhaust partially the acid receiver, and the stop-cock is turned on. The effect of this preliminary manipulation is to firmly attach the flask to the tube by atmospheric pressure, and insure a perfectly air-tight joint. The pump is now worked rapidly for a few minutes, when the water in the flask begins to evaporate rapidly, and at last bursts into violent ebullition. The vapor evolved is drawn through the receiver containing the acid, which at once absorbs and condenses it. Very soon a few filaments of ice will be observed to form in the water, and the pumping is to be continued for a few minutes longer, after which a stop-cock connecting the pump with the receiver is closed and the flask left on the tube. In fifteen or twenty minutes afterward the water will be found to be frozen throughout. The flask can then be removed and another substituted, and if the stop-cock between the flask and the receiver was closed previous to the removal of flask No. 1, the vacuum in the receiver will have been preserved, and much of the preliminary pumping may be dispensed with in the case of flask No. 2.

The theory of this operation is the same as that of the familiar lecture-room experiment of freezing water by its own evaporation. In the case of M. Carré's device, the rapid evaporation of the water effected with the pump by relief of pressure is materially aided by powerful absorptive qualities of the sulphuric acid in the receiver; and in order to insure better contact of the acid and vapor, an ingenious apparatus called the agitator is provided by the inventor, which stirs up the acid during the motion of the pump. This agitator consists of a rocker furnished with paddles, and extending the length of the receiver, the motion of the rocker being obtained by means of a lever attached to the pump-handle. The apparatus is carefully constructed, so as to avoid the entrance of acid either into the flask or the pump, so that the employment of the acid need afford no inconvenience to the

introduction of the machine in private houses. The acid may be removed and replenished when necessary by means of a suitable opening provided on one end of the receiver. When the acid is fresh, the freezing operation is much more rapid than when a number of carafes have been frozen, a natural consequence of the weakening of the acid by dilution from the absorbed vapor. When the efficiency of the acid has become notably impaired, it must be removed and replaced by fresh material. The cost of freezing a single carafe is estimated to average about one half to two thirds of a cent where the acid is thrown away after its work is performed; where the diluted acid can be utilized, this estimate will of course be materially lessened. The carafe, or decanter, half filled with ice, is to be completely filled with water, and is thus brought upon the table, being replenished with fresh water when empty. The shape of the decanter renders the melting a slow process, and when once partially filled with ice it will supply cold water for the greater part of the day. If desired, however, it is obvious that the same machine, with a suitable modification of the water-vessels, can be made to furnish ice blocks of any size or form.—*American Exchange and Review*, XXVII, 272.

N. MATERIA MEDICA, THERAPEUTICS, AND HYGIENE.

JOLLY ON PHOSPHATE OF LIME.

Dr. Jolly, in correction of a previous memoir on the phosphate of lime, remarks that of the two elements, phosphoric acid and lime, constituting the soluble and insoluble, the former is absorbed in a certain proportion at once; the second, or the lime, is rejected almost entirely by the intestinal canal.

The soluble preparations of the phosphate of lime act finally as acid principles; then, in consequence of the changes which they undergo in the intestines, they act secondarily as phosphatic agents of another base.—12 *B, June* 30, 548.

HYPODERMIC INJECTION OF LACTATE OF SODA.

Dr. Preyer, of Jena, has called renewed attention to the fact that a preparation of lactate of soda injected under the skin, or introduced into the stomach, will produce a somnolence quite similar to natural slumber. The application of this through the mouth has been tried with much success in some cases, although in others it has been quite inefficacious.—13 *B, April* 22, 1876, 534.

THERAPEUTICAL VALUE OF SILPHIUM.

Considerable attention has lately been paid to the subject of the therapeutical value of plants of the genus *Silphium*, to which the well-known "compass weed" of the Western prairies belongs. It is used more particularly in cases of phthisis, and, according to Dr. Laval, produces the following results: First, the reappearance of appetite, if this has disappeared; second, the relief of the difficulty in breathing and an easier respiration; third, a much less painful cough, the phlegm being more natural, and indicating less the phenomena of tuberculosis. All these effects, increase of appetite, augmentation and modification of the bronchial secretions, and easier respiration, show that important functional activity is produced by the use of the medicine.

According to other authors, however, caution is to be exercised in its administration, as in certain stages it may do more harm than good. Further and more extended experiments will be required in order to determine precisely how to apply this remedy, and, indeed, whether it has the virtues attributed to it by its sanguine advocates. It is to be remarked that the ancients attached great therapeutic virtue to the use of silphium, considering it as a true panacea.—11 *B*, *July* 1, 353.

NEW SUBSTANCES OF THE MATERIA MEDICA.

At the recent Pharmaceutical Congress held at Bristol, England, an account was given by Mr. Groves, the president, of sundry new drugs, some of which are probably destined to occupy a prominent place in the Materia Medica. Most of them were brought from South America, and as yet are but imperfectly understood. One of these is known as *Butea*, which is said to contain a basic substance, which combined with sulphuric acid is white, almost like cinchona, and is exported to Europe in great quantities to adulterate quinine. *Erva de Rato*, a cinchonaceous plant, used in Brazil for killing rats and mice, is another drug which is said to exert an action upon the heart similar to that of digitalis. Certain substances, known as *Goa*, *Bahia*, and *Araroba powders*, and claimed to have quite different effects, have lately been shown to be one and the same thing, the plant having been exported from Bahia to Goa, and thence introduced into Europe. The essential principle of these powders, as recently separated, has been called *Chrysardhin*, and contains from eighty to eighty-four per cent. of pure chrysophanic acid, long known as a constituent of rhubarb roots. This is considered in Brazil as almost a specific for certain forms of skin disease. Another substance mentioned was *Gurgun balsam*, an oleo-resinous fluid, obtained by making incisions in the bark of *Dipterocarpus lævis*. This, for a time, was used principally as an adulterant of copaiba, but is now believed to be a very valuable agent in the treatment of skin diseases, especially leprosy; indeed, it is said that *Gurgun balsam* renders this disease quite tractable, sometimes curing it, and in most cases alleviating it. It is applied in emulsions with lime-water, internally and also as an ointment. It is also urged

as applicable in cancer. An elaborate series of experiments is now being prosecuted by the Indian government to determine its availability in similar cases. Salicylic acid was also dwelt upon as an important addition to the resources of the pharmaceutist. Its great superiority to carbolic acid in most cases was pointed out, which, combined with its much less objectionable taste and flavor, will doubtless call it extensively into use. Introduced in small quantities into the water in which leeches are kept, it preserves those animals in a healthy condition, showing its non-poisonous character. The speaker thought its future applications were more likely to be internal than external. Reference was made to the artificial preparation of oil of winter-green (salicylate of methyl), prepared from the artificial acid, and possessing the taste and odor of the oil of the plant on distillation. The interesting fact was stated that salicylic acid can be obtained in nearly pure crystals from the essential oil of *Andromeda Leschenaultii*, a plant growing in inexhaustible profusion on the Neilgherry Hills. By saponifying the oil with potash and adding a mineral acid, the salicylic acid is precipitated in a state of purity. If this is distilled with lime and sand, pure carbolic acid is obtained. It is thought that both these acids can be obtained from the plant at a cost of a few shillings a pound. A substance has lately been derived from the roots of the *Digitalis purpurea*, which is so poisonous as to render doubtful its availability for medicinal purposes.—18 *A*, *October* 18, 1875, 89.

ON JABORANDI.

Among the most remarkable objects of the Materia Medica lately introduced to notice is one known as *Jaborandi*, and especially noteworthy from its power of producing a rapid, prompt, and intense salivation. The plant is a native of the Empire of Brazil, and known to botanists as the *Pilocarpus pinnatus*. Four grammes of the leaves dissolved in 125 grammes of boiling water, or in 20 grammes of alcohol, will bring about at the end of twenty to forty minutes a perspiration which continues from one to two hours, and is enough to completely saturate the clothing or even the bedding of the patient with moisture, to an amount estimated at from three to five hundred grammes.

Dr. Albert Robin has lately received the sum of 1500 francs, from the Barbier prize, for an essay upon the applications of this substance; and, in addition to the determination of the facts just mentioned, he has shown that in the amount of perspiration thus produced there is an elimination of urea of about one gramme, and of chlorides of about one gramme and a half. Experiments have been tried also upon dogs and guinea-pigs, which, as not being provided with sudorific glands, gave no result, and even with horses, which have such apparatus, no satisfactory experiment could be made. A secretion of saliva, according to Robin, commences and continues equally with that of perspiration, and he determined an elimination of 400 to 500 grammes in about two hours—an amount forty times that of natural salivation. The saliva proved to be viscid, very alkaline, and charged with mineral salts, especially the carbonates and chlorides. The secretions of tears, and of the bronchial and nasal mucus, are somewhat increased, but much less in proportion than the others mentioned. The occasional nausea produced by the application of Jaborandi is due, according to Robin, to the swallowing of the saliva, which should therefore be carefully avoided. The urinal secretion was slightly diminished by the use of this drug. The therapeutic value of Jaborandi, the author considers very great, and among other applications is the treatment of acute articular rheumatism, in which, in nearly every instance, there was a notable diminution of pain during and after its action, a better sleep, and a decided decrease in the duration of the malady after two or three administrations for several days. Three patients who had muscular rheumatism were promptly relieved; two were cured of pneumonia, and the third case was fatal from causes beyond the reach of any medicine; very favorable results were produced in cases of bronchitis and asthma; and in twelve cases of Bright's disease, every one received a decided benefit from the treatment. Another paper on Jaborandi, which likewise received a prize of 1500 francs from the Academy of Sciences, was that by Hardy, upon the active principle of Jaborandi, which he calls *pilocarpine*. This is an alkaloid, solvable in water and in alcohol. It has been isolated, but not yet actually obtained in a crystallized form. So far as can be judged, the alkaloid contains all the active

properties of the plant, and can, consequently, be used in many cases to much better advantage.—6 *B, December* 22, 1875, 1333.

THERAPEUTIC QUALITIES OF COD-LIVER OIL AND QUININE.

The *Paris Medical Journal* commends a certain preparation of quinine and cod-liver oil as having excellent therapeutical virtues. The experiment had been frequently made of dissolving quinine with cod-liver oil, but without success; subsequently the object was accomplished by combining the alkaloid with oleic acid, and then dissolving this oleic acid in a given quantity of cod-liver oil. The French preparation of this substance is arranged to give five centigrammes of quinine to each tablespoonful of the oil.—1 *B, January* 2, 1876, 206.

CHEAP QUININE.

It is reported that the extensive cinchona plantations in British Sikhim have lately begun to furnish an efficient febrifuge, sold at a cheap rate. The resident manager of the plantation at Darjeeling writes to Dr. Hooker that they expect to collect about ninety tons of the dry bark during this season; that they are making it on the spot into a febrifuge which is evidently quite as effectual as quinine. They are making from forty to fifty pounds a week, and expect to increase the quantity, and hope to sell this at about fifty cents an ounce.—12 *A, January* 6, 1876, 196.

CHLORAL AND PICROTOXINE.

Dr. Christian Brown has shown that the hydrate of chloral is physiologically the antagonist of picrotoxine, when administered to hares and rabbits and guinea-pigs, and that life may be saved, after a fatal dose of picrotoxine, by administering the chloral within fifteen or twenty minutes of the taking of the other substance. This antagonism is subject to two restrictions: first, when the dose of picrotoxine is large enough to destroy life before the chloral has had time to act; and, second, when the dose is too great to be combated, excepting by a fatal dose of chloral. On the other hand, however, picrotoxine is only to a very limited degree the antag-

onist of chloral, merely mitigating the hypnotic effects upon the brain and nervous system. The minimum fatal dose of the hydrate of chloral for the hare is twelve grains for each pound of weight of the body. With the cat it has been found that there is practically no antagonism between picrotoxine or strychnine and chloral. Picrotoxine and hydrate of chloral administered together to a cat produced death by stopping the action of the heart, apparently without exciting any destructive or exhausting influence upon the superior nervous centres. The energy of the action of hydrate of chloral, however, in its fatal minimum dose, according to Dr. Brown, is in proportion to the development of the cerebral hemispheres.—12 *B*, LXXXIX., 142.

ACTION OF BROMIDE OF LITHIUM.

The use of bromide of lithium as a remedy appears to be increasing since the first suggestion of its application by Dr. S. W. Mitchell, of Philadelphia, in 1870. Dr. Levy, a French physician, has reported as the result of careful investigation that while the bromide of potassium exercises a decided action on the muscular system, bromide of lithium has apparently none in this respect, but acts more energetically and more rapidly than the potassium upon the spinal marrow and nerves of sensation. He also states that there is an influence of the bromide of lithium, though slight, upon gout; but it is quite difficult to prove any influence in diminishing the quantity of uric acid secreted or contained in the urine. It has, however, a very decided sedative action upon cerebro-spinal cases, and has favorably modified various diseases, especially epilepsy. While its action in this respect is more marked than that of the bromide of potassium, it has the additional advantage of not acting upon the heart—a matter of much moment in some cases. He thinks, therefore, that in any event the bromide of lithium deserves an honorable mention in therapeutics. The doses in which Dr. Levy administers this remedy are 50 centigrammes for the gout, and 20 centigrammes for such nervous conditions as hysteria, insomnia, etc. For epilepsy he uses at first 50 centigrammes, increasing the amount gradually to 2½ or 3 grammes. There is no danger, he thinks, in giving doses even greater than this.—12 *B*, LXXXVIII., 286.

EXTRAORDINARY ACTION OF NITRATE OF AMYL.

The nitrate of amyl has within the last few years obtained a remarkable importance, owing to its extraordinary action upon the body. It appears that Professor Guthrie, a distinguished chemist, while distilling nitrate of amyl from amylic alcohol, observed that the vapor when inhaled quickened his circulation, and made him feel as if he had been running; there was flushing of his face, rapid action of his heart, and breathlessness. On making a careful and prolonged study of the properties of this singular body, Dr. Richardson discovers that it produces its effects by causing an extreme relaxation, first of the bloodvessels, and afterward of the muscular fibres of the body. To such an extent does this agent thus relax, that, finding it would overcome the tetanic spasm produced by strychnia, he has ventured to propose its use in some of the most extreme spasmodic diseases, and thus far with surprising success. Under the influence of this agent one of the most agonizing of known human maladies—angina pectoris—has been brought under such control that the paroxysms have been regularly prevented, and, in one instance at least, altogether removed. Even tetanus, or locked-jaw, has been subdued by it, and, in two instances of an extreme kind, so effectively as to warrant the credit of what may be truly called a cure.

INFLUENCE OF ALTITUDE UPON THE HEALTH.

Dr. Gleitsmann, physician in charge of the Mountain Sanitarium for pulmonary diseases at Asheville, North Carolina, states that in the treatment of pulmonary diseases several historical epochs may be recognized—that in which the sea climate was considered as most beneficial, that in which dry climates were advised, and that in which elevated regions were recommended. The most recent theoretical investigators, as well as many physicians, however, agree that in the removal of the patient to elevated regions we do for him the very best that can be done. Dr. Gleitsmann finds that the success attained by the removal of the patient to southern climates, without securing a greater altitude, amounts simply to a relief of the symptoms, only warding off fresh injury; the patient, after returning home, has not acquired that power of

resistance which alone can prevent a new catarrh or inflammation from attacking the lungs. The general effect, on the other hand, of a mountain climate must be considered as an active one, since increased demands are made upon the functions of the organism from all sides—mechanical, chemical, and dynamic.—*Transactions of the Medical Faculty of Maryland*, 1875.

EFFECTS OF CHOLERA ON THE MUCOUS MEMBRANE.

In a valuable report to the United States government upon the microscopic examination of the intestines in cases of cholera, Dr. Danforth says that not only are the mucous and muscular layers much disturbed and widely separated, showing between them a beautiful loosely woven web of areolar or connective tissue, but that not a single perfect villus can be seen; a few stumps only remain. The surface of the mucous layer is quite denuded, and the clothing of epithelium stripped from its surface. Peyer's glands are not much altered. It seems almost beyond belief that a few short hours can so totally change the intestinal surface.—*Monthly Microscopical Journal, March*, 1876.

THE BLOOD IN TYPHOID FEVER.

M. Comil has found, in the blood of the spleen of patients who have died in the third week of typhoid fever, large numbers of white globules, inclosing red globules to the number of five or six, or even more, in a single cell. Though this is nothing new, M. Comil is the first to insist upon their multiplication in typhoid fever.—*Monthly Microscopical Journal, May*, 1876.

ASIATIC CHOLERA.

Dr. Bonnafont, in a communication upon the Asiatic cholera read before the Academy of Medicine of Paris, enunciates the following general propositions: First, this disease can not originate spontaneously in any other country than India, but must reach other regions by transportation, or by germs of the disease, atmospheric currents, or some other vehicle; second, all hygienic methods to avert this plague must be initiated and maintained in the country of its origin; third, that it is not the dead bodies of animals aban-

doned on the soil by caravans of pilgrims, nor the number of human bodies thrown into the Ganges, that produce the eruptions of the Asiatic cholera, as these practices have prevailed for ages, while appearances of epidemic or Asiatic cholera in Europe, Africa, or America date only from the beginning of the present century; fourth, other causes, therefore, must exist for the frequent movements of this disease, and it is in India that these are to be investigated; fifth, secondary epidemics may perhaps be developed in points already infected; but, with very rare exceptions, they never assume the exact features of genuine cholera, and they will generally fade out and disappear until reinforced by a new eruption from the original starting-point. Therefore the special points to be considered are the questions why cholera has remained for centuries in an endemic and stationary condition in India, and why it has recently emerged, though the atmospheric conditions, and the manners and customs of the Hindoos and pilgrims, apparently remain unchanged.—1 *B*, XV., 299.

PECULIAR DISEASE AMONG DOGS IN CHINA.

The dogs of China are subject to a curious infliction, known as "worms in the heart," the symptoms of which are the vomiting of blood, staggering, and death within twenty-four hours of the attack. In one instance, in dissection, a continuous rope of worms was found, fourteen inches long, stretching from the right hepatic vein through the cava into the right auricle, and thence, by a fine twist of one or two worms, through the tricuspid valve into the right ventricle, together with a rope of worms, fourteen inches long, stretching into both lungs. The precise species of entozoon has not been indicated, but it produces death very quickly, mostly in a mechanical way, by blocking up the bloodvessels and cavities of the heart. Treatment is difficult, as the disease is seldom recognized during life, and when death comes, it is so sudden as to give but little time for remedies. Even if the worms could be killed, they would probably be as injurious dead as alive, so far as choking up the heart goes. The problem is not yet solved as to the mode of their entrance into the circulation.—2 *A*, XIX., 357.

TREATMENT OF ASTHMA.

It is generally supposed that an antagonism exists between atrophia and morphine, by which the one neutralizes the other, and this may possibly be the case where either is administered separately, and is followed by the application of the other at some interval. According to Dr. Oliver, however, when the two are combined in the form of a hypodermic injection, some of the more uncomfortable effects are relieved in certain cases, if not entirely removed. This writer insists that the general result is a more rapid action, and almost entire absence of disturbance of the stomach in the production of nausea, so distressing to patients who have been treated hypodermically with morphine alone.

The treatment of the physician referred to is more particularly applied in cases of attack of spasmodic asthma. At first the injections were administered after the attack itself; subsequently, however, the friends of the patient were instructed in the use of the instrument, and used it immediately on the first indication of the trouble. This was continued for a period of three years, during which every one of the attacks, previously so distressing, was entirely prevented. The injections were made in the morning for several days in succession. The continued employment of these injections did not appear to be at all injurious to the general health. A prompt relief was usually produced in five minutes, resulting in a calm slumber. The most severe attack disappeared in from fifteen to twenty minutes. A similar good effect from the combination of the two substances has been found in the treatment of dyspnœa.—12 *B, February* 29, 1876, 184.

FRENCH INVESTIGATION OF HAY-FEVER.

The *Bulletin Scientifique*, of Paris, refers approvingly to the opinion expressed by M. Decaisne concerning hay-fever. He does not think the annual periodicity, which is usually given as one of the characteristics of the disease, to be well established, many persons being sometimes free for years in succession, and others experiencing several attacks at irregular intervals. The difficulty of breathing, which is sometimes considered an inseparable condition of hay-fever, is, according to this authority, simply the result of a more de-

cided extension of the irritation which attacks the conjunctiva and the nasal and pharyngeal mucal surface. So far, too, from there being any greater tendency to the disease among hay-makers and farmers than any class of the community, the affection appears, in fact, to attack agriculturists and persons of other occupations indifferently—showing that the emanations from forage plants can have, at most, only a very secondary influence in the case. All the symptoms are exhibited at any season, as the result of sudden exposure to cold when the body is in a condition of perspiration, whether subjected or not to dust or other irritating emanations. The disease must be regarded, therefore, as simply a catarrhal fever, influenced and modified in its origin and progress according to individual peculiarities and by atmospheric conditions.

COCHIN-CHINA DIARRHŒA.

The Cochin-China diarrhœa annually carries off about 1000 men of the French army and navy. According to Dr. Normand, naval surgeon, this disease is produced by the presence in the intestines of an enormous number of intestinal worms, of the new species, *Anguillula stercoralis.* It is one fourth of a millimeter in length.—*Popular Science Monthly, November.*

INDIAN CORN AND ENDEMIC PELLAGRA.

In Southern Europe, and especially in Italy, in localities where maize is largely consumed by the poorer classes, pellagra has long been prevalent, and has been almost exclusively confined to such as subsist for the most part on corn meal. In Cremona one out of every twenty-four of the population is thus afflicted, and in Brescia one in forty-one, and the number is annually increasing. The mould *Sporisorium maidis,* detected on grains of corn in 1870 by Bellardini and Cassati, was suspected as the cause of the disease, as well as the common mould, *Penicillium glaucum,* so frequently found on improperly dried and imperfectly stored corn. According to the observations of Professor Lambrosa, however, there is no connection between those fungi and the pellagra, but the disease originates rather in the rancidity of the fatty oil, richly present in corn meal. He showed that the disease

can not be excited either by introducing the above moulds into the stomach or directly into the circulation, but that it can be produced by the administration of corn meal that has become rancid. He contends, therefore, that the disease in Lombardy results in part from late planting, which prevents the ripening of the grain, and that planting too thickly, harvesting too early, drying the ears imperfectly, together with storage of the corn and meal in damp places, all contribute to render the disease epidemic. He attributes the total absence of the disease from portions of America where maize is almost exclusively used for food to the thorough ripening and drying of the grain, and the conversion of comparatively small portions into meal at a time. He recommends, therefore, the keeping on hand of but a limited supply of freshly ground meal, and the preparation of small cakes instead of the usual large loaves, which are seldom baked through, and which, as they are often kept fourteen days, are very liable to spoil. According to Professor Haberland, the disease has not yet been noticed in the southern portions of Austria, where corn is also largely consumed. He suggests that the rancidity may be prevented with certainty by removing the oleaginous germ before grinding.—1 C, 1875, 218.

IMPROVED DENTAL PROCESS.

Napier, the well-known English dentist, has devised what he considers a valuable process in dental surgery, especially in a case where the teeth are extremely sensitive, and it becomes necessary to file them down for the purpose of introducing artificial teeth on the stumps. For the sake of avoiding pain in the operation as far as possible, ether spray is first made use of in reducing the sensibility of the teeth—a piece of cotton dipped in ether and laid first on the teeth and then on the instrument being found to answer a still better purpose. While engaged in this operation, it occurred to Dr. Napier to avoid the usual practice of dentists of extirpating the nerve, with which object he took a bit of hard wood, dipping it in nitric acid, and with this cauterizing the exposed portion of the nerve in each tooth successively. He then filed the teeth down to the level of the gums without producing any pain whatever. He found that in this way the

stump of the tooth remained perfectly healthy, giving no pain of any kind, and that the subsequent experiences of the patients were of the most satisfactory nature.

POISONOUS PROPERTIES OF GLYCERINE.

In a paper by Dujardin-Beaumetz upon the poisonous properties of glycerine, it is stated that this substance, chemically pure, when introduced under the skin of a dog, causes death in a dose of eight to ten grammes per kilogramme of the weight of the body, the general symptoms of the poison being those of alcoholism.—12 *A*, *July* 30, 65.

POISONOUS PROPERTIES OF FUCHSIN.

The question of the poisonous properties of fuchsin, now so extensively used as a dye, as also for coloring wines, has been a subject of much contention by chemists and toxicologists. It is now quite generally accepted that when chemically pure it is harmless, being dangerous only when containing foreign impurities. This conclusion has quite recently been reached by Poisson, who fed rabbits in successive doses with pills of this substance, chemically pure, without producing any apparent injury. On killing the rabbits the viscera were all brightly colored with violet red, but no inflammation or lesion was appreciable in any part.

REPORT OF MASSACHUSETTS STATE BOARD OF HEALTH.

An important addition has been made to the valuable documents published by the Massachusetts State Board of Health, in the form of a special report on the pollutions of certain rivers in the state, such as the Blackstone, Charles, Chicopee, and others, with general observations on water supplies and sewerage, as prepared by Mr. James P. Kirkwood. There is also an appendix, containing certain analyses by Professor Nichols; "The Drainage and Sewerage of the State from a Sanitary Point of View," by Dr. Winsor; and "The Disposal of Sewage," by Dr. Folsom. The report closes with series of summaries and recommendations.

From this report we learn that the most widespread evil in Massachusetts, as brought out by the investigations of the board, is the dampness of soil arising from incomplete drainage, or the lack of removal of the water.

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The general question of the disposition of sewage is one that has occupied the attention of the board. A well-ordered water supply, water-closets, and suitable drainage in connection with a system of sewers is, of course, the best. The substitutes for water-closets are, first, frequent disinfection with dry earth, and prompt and frequent removal of all excrement; second, the disposition of slop-water in such a way that it can not putrefy and contaminate the air in the neighborhood of dwellings. This is well attained by a system of irrigation devised by Mr. Rogers Field, of London; but where this can not be adapted, it is said that the safest way is to dispose of slop-water on the surface of the ground not near dwellings, where the organic matters in suspension or solution will be taken up by vegetation. All tanks, reservoirs, cesspools, etc., may be always looked upon as likely to cause serious trouble under the immense majority of circumstances.

CINCINNATI HAMS.

The health authorities of Paris have lately prohibited the sale in that city of Cincinnati hams, which, as is well known, are generally put up in canvas, colored of a brownish hue. According to the results of a chemical investigation, this color is due to chrome-yellow, or the chromate of lead, which is in itself a highly poisonous substance.

Professor Bouchardat suggests, in a communication on the subject, that if a brown color for this purpose is desirable, there are numerous substances, such as curcuma and others, which are entirely inoffensive, and which would be equally valuable in producing the general effect of color.—12 *B*, *May* 15, 1876, 430.

EXCLUSION OF DUST FROM THE LUNGS.

Dr. B. W. Richardson, in a series of lectures upon unhealthy trades, recently delivered in London, mentions a new device for the filtration of dust, the injuries from which are known to be among the most serious to which mechanics and operatives are subjected. Whenever filings and fine dust of any kind are produced, it is very important to prevent the introduction of particles of the foreign substance into the lungs, as even an occasional exposure may do great harm, while

one continued for many months or years almost inevitably produces fatal results.

Dr. Richardson states that the principal conditions in a mask, in order to secure perfection of action, are a free entrance of air and freedom of exit, with balance for respiration and expiration so arranged that the expiration should be at least one sixth freer than the inspiration; second, the removal of the water of expiration; third, selection of a material for filtration that shall absorb the smallest possible amount of water, offer as little resistance as is possible, and filter finely; fourth, arrangement of the filter so that it should, as far as possible, clear itself, in expiration, of the dust it had received during the time the air was being drawn through in the act of inspiration.

For these purposes numerous devices have been presented; among them one by which the air is passed through cotton. In this, however, the cotton soon becomes saturated with water; the breathing is difficult even in pure air. A second form, made of layers of crape spread over a light framework, is easily put on and off, and it admits the passage of the air in either direction freely, but it allows the water to accumulate in the meshes, and it filters badly. It answers fairly for very coarse dusts, but the finer sorts, such as flour, are not excluded.

Other very complicated forms were mentioned; but the one to which the lecturer referred as having all the good qualities and none of the disadvantages of the rest is made of feathers arranged around the outside of a perforated breathing tube of a convenient size, a line of feathers being fastened to the tube, and wrapped around it so closely as to cover all the perforations. By breathing through the upper end of this tube, the feathers come down to the perforations in inspiration, and expand in expiration so as to be lifted from the openings, and all the intercepted dust is blown off. Very little moisture is collected, and the apparatus is considered almost perfect.

The tube is fastened in a mask, which is tied around the feathers, so as the more readily to keep them in the proper position. It can be put on and taken off as easily as if it were a pair of spectacles. The filter-tube is placed below, so as to catch all the inspired air, and by means of the two

side expiratory valves nearly all the moisture of the breath is set free.—18 *A*, *June* 9, 1876, 326.

ELECTRICAL ALARM AGAINST CARBONIC OXIDE.

The following is the general construction of a small apparatus, designed by Ansell, which is said to indicate the presence of a comparatively small amount of carbonic oxide in the atmosphere by starting an electrical alarm, and seems to be especially adapted to sleeping-chambers, where there may be any danger from the escape of gas. A pear-shaped vessel, closed at the top with a porous membrane—best with an unglazed earthen plate—is connected at the bottom with two communicating tubes filled to a certain height with mercury. The tube not immediately connected with the vessel ends in a small hollow glass bulb, containing a platinum wire reaching nearly to the mercury. The poles of a battery, including in its circuit an alarm-bell, are connected respectively with this wire and the mercury. In an atmosphere containing carbonic oxide, this gas, of lower specific gravity, will diffuse so much more rapidly through the porous membrane into the vessel filled with air, that sufficient pressure will be produced to cause a depression of the mercury in the tube connected with it, and a corresponding elevation of it in the other, until it comes in contact with the platinum wire, when the alarm will be sounded by the completion of the circuit.—18 *C*, *February* 9, 1876, 81.

O. NECROLOGY.

Angelin, Nils Peter. For many years Superintendent of the Paleontological Department of the Royal Museum at Stockholm, and author of numerous memoirs on the geology and paleontology of Sweden. Died February 13th, at the age of seventy.

Balard, M. Member of the Academy of Sciences of Paris, and Professor of Chemistry at the Sorbonne. Died in Paris, at the age of seventy-four.

Baudeira, Marquis Sa de. Author of several papers on the Portuguese possessions in Africa. Died at Lisbon, February 6th, at the age of eighty-one.

Becher, Rear-Admiral A. B. Entered the British navy in 1812, and became editor of the *Nautical Magazine*, after a period of service in surveying on the Canadian lakes, in the Hydrographic Office, and in the Admiralty. In 1856 published "The Landfall of Columbus," identifying Watling Island with Guanahani. Died February 14th, in the eighty-fourth year of his age.

Bird, Frederick. An astronomer; specially skilled in polishing mirrors of telescopes. Died at Birmingham, September 27th, aged sixty.

Bleek, Dr. W. H. D. Born in Berlin in 1827. Distinguished as a philologist, and an author of several works upon the languages of South Africa, Australia, and Polynesia. Died August 17th, at Capetown, in the fiftieth year of his age.

Boeck, Dr. William. Author of important works on elephantiasis and other diseases. Died at Christiania, December 10th.

Bollaert, William. An explorer in Central and South America; especially interested in geology and archæology. Died November 15th.

Borlan, Alexander. A local botanist of Angers, France.

Brongniart, Adolphe. An eminent French naturalist. Born January 11th, 1801. Author of many important botanical works, and one of the founders of the *Annales des Sciences Naturelles.* Died February 18th, at the age of seventy-five.

Buchholz, Dr. R. Well known in connection with polar exploration, and more recently with travels in Central Africa. Died April 17th.

Carrington, R. C. Known as the proprietor of Red Hill Observatory, and subsequently of the observatory at Churt, near Farnham, where he died, November 1st; author of a catalogue of circumpolar stars.

Chekanovsky, —. An exile to Siberia, he devoted many years to the study of the geology of that country, and made extensive collections on the shores of the Polar Sea. Died in October.

Cornelissen, Lieutenant J. E. Head of the marine branch of the Utrecht Institute. Died at Brussels in March.

Cresson, John C. Professor of Mechanics and Natural Philosophy in the Franklin Institute of Philadelphia, of which body he was president. At the time of his death, January 12th, aged seventy, was chief-engineer of the Philadelphia Park.

Davies, Professor Charles. A well-known author of mathematical text-books, a West Point graduate, and Professor of Mathematics in Columbia College from 1857 to 1867. Died on the 18th of September, in his seventy-ninth year.

Delvigne, Gustave. Inventor of an explosive bullet and rifled gun.

Desmoulins, Charles. President of the Linnæan Society of Bordeaux. Died December 23d, 1875.

D'Orbigny, Professor. An eminent French zoologist, and connected with the Paris Museum of Natural History.

Edwards, F. E. Author of several valuable monographs on various groups of eocene mollusca. Died in England, October 15th, at the age of seventy-six.

Ehrenberg, Professor C. G. Born in Prussian Saxony in April, 1795. An eminent microscopist, and author of several works on infusoria; making a specialty of the examination of deep-sea soundings, a great number of new species of these minute organisms having been described by him. Received many honors in the way of membership in learned societies; was Secretary of the Academy of Sciences of Berlin, a member of the Royal Society of London, and one of the eight foreign associates of the Academy of Sciences of Paris. Died June 27th, in the eighty-first year of his age.

Fearn, Thomas. An accomplished metallurgist of England. Died in September.

Forbes, David. Foreign Secretary of the Iron and Steel Institute. Died December 5th, at the age of forty-nine.

Fuckel, Leopold. Well known for his mycological writings, and his published collection of fungi, entitled "Fungi Rhenani." Died at Vienna, May 8th.

Gamond, Thomé. Born in Paris in 1798; educated in Holland; was the originator of the Channel Tunnel enterprise. Died in February, at the age of seventy-eight.

Grattoni, Signor Severino. An Italian engineer, and superintendent of the construction of the Mont Cenis Tunnel.

Gray, Mrs. Widow of the late John Edward Gray of the British Museum. Died at an advanced age.

Guichenot, Alphonse. Well known for his connection with the chair of herpetology and ichthyology in the Museum of Paris. An assistant on

the systematic works upon the natural history of Chili, Cuba, and elsewhere, published under the direction of the French government. Died February 17th, aged sixty-seven.

Hearder, Dr. Jonathan. An inventor and manufacturer of many forms of electrical and chemical apparatus, an early advocate of a telegraphic cable across the Atlantic; also a manufacturer of fishing-tackle and other apparatus for the capture of fish, his trawl-nets having been used by the British *Challenger* expedition and the United States Fish Commission. Died at Plymouth, England, July 16th, at an advanced age.

Jacobi, Lieutenant-General. The monographer of the genus Agave. Died at Berlin.

James, Dr. Born in Richmond, Virginia. Surgeon and naturalist of the *Chevert*, a vessel fitted out by Mr. Maclay for exploration in New Guinea. An accomplished collector. Killed by the natives of Yale Island, New Guinea, September 15th.

Jelinek, Dr. Carl. A distinguished physicist, and publishing much relating to magnetism and meteorology. Director of the Central Institute for Magnetism and Meteorology at Vienna. Died at Vienna, October 9th, aged fifty-four.

King, Dr. Richard. A companion of Sir George Back in his arctic travels, of which he wrote a narrative; author of many articles of a medical and sanitary nature, and editor of a statistical and ethnological journal. Died February 4th.

Kopp, Professor E. An Alsatian by birth; a professor in the University of Strasburg previous to 1848; afterward Professor of Chemistry in the Polytechnic School of Zurich; well known as a writer on the history and progress of the coal-tar colors. Died November 3d, at the age of fifty-nine.

Kowalevsky, Dr. J. Secretary of the Caucasian section of the Imperial Russian Geographical Society, and editor of its publications.

Laplace, Admiral Cyrille. Well known as connected with numerous voyages of discovery, the results of which added much to the knowledge of physics and natural history of the globe. Died at Brest, January 24th.

Leigh, Evan. Inventor of the "twin screw," and other details connected with cotton machinery. Died at Manchester, England, February 2d, in the sixty-fifth year of his age.

Letheby, Dr. Distinguished as an analyst, and for many years medical officer of health in the city of London. Died in April, at the age of sixty.

Lucas, Louis A. A well-known African traveler. Died near Jeddah, on the Red Sea, in November.

Macaya, de Cortera. Born in 1800. Well known as Secretary and President of the Geographical Society of Paris, and author of numerous essays upon geographical subjects. Died in Paris, January 14th, aged seventy-six.

March, William T. A resident of Jamaica, and specially interested in its birds and plants. Author of several papers on Jamaica birds. Died at an advanced age.

Marvine, A. R. Born 1848. United States government geologist and explorer. Died at Washington, March 2d.

Meek, Professor Fielding B. One of the most distinguished of American paleontologists. Died at the Smithsonian Institution, December 22d, aged fifty-nine.

Melville, Andrew Smith. Lecturer on botany and geology in the Edinburgh School of Arts. Died July 22d.

Miller, Mrs. Widow of the late Hugh Miller. Died at the age of sixty-four.

Minascalchi-Erizzi, Count. A founder of the Italian Geographical Society. Died December 30th, 1875.

Mohl, Professor Jules de. Professor of Persian in the College of France. Died at the age of seventy-six.

Munzinger, Werner. A Swiss by birth; an eminent explorer in Africa; author of several valuable works, and contributed largely to the journal of the Royal Geographical Society.

Napier, Robert. Born in 1791. An eminent citizen of Glasgow, distinguished among British engineers, and as the proprietor of the great establishment at Glasgow for the manufacture of marine engines, and as the builder of most of those of the Cunard steamers. Died June 22d, at the age of eighty-five.

New, Charles. A well-known missionary and traveler in East Africa. Author of various notes of travel. Born in 1840. Died at Duruma, February 14th.

Newman, Edward. An eminent naturalist, his labors having special reference to entomology and the ferns. Best known as the editor of the *Zoologist* and the *Entomologist*. At the time of his death in charge of the natural-history department of the London *Field*. Died at Peckham, England, June 12th, at the age of seventy-five.

Noltke, Ernst Ferdinand. A veteran botanist of Kiel. Died February 13th, at the age of eighty-four.

Parkes, Dr. A well-known army surgeon; author of many important papers of physiological and biological merit. Died in March, at the age of fifty-six.

Pertz, Chevalier. For many years librarian of the Royal Library of Berlin. Died in October.

Pfunds, Dr. Attached to Colonel Colston's expedition to Kordofan and Dar Fur. Died at the latter place, August 23d.

Pictet, Adolphe. An eminent writer on ethnology and comparative philology. Died at Geneva, in December, at the age of seventy-six.

Ponier, Porter. A most promising student of physical science. Died at Newark, New Jersey, June 11th, at the age of twenty-three.

Redmond, M. An English missionary traveler in Africa.

Redtenbacher, Dr. Ludwig. Director of the Imperial Zoological Museum of Austria. Author of numerous works on entomology, etc. Died at Vienna, February 8th, at the age of sixty-three.

Reuschle, Professor K. G. Author of many works on geography and physics. Died at Stuttgart, May 23d, at the age of sixty-five.

Rizaux, Professor. Radcliffe astronomical observer at Oxford.

Rousseau, Henry. One of the founders of the Troy Lyceum of Natural History. Died in that city, September 19th, at the age of seventy-five.

Russell, Alexander. Author of a standard work on the salmon. Died in Glasgow.

Scrope, George Poulett. Born in London in 1797. An eminent geologist, his specialty being the investigation of recent and extinct volcanoes and the phenomena of igneous rocks generally. Author of many important works relating to these subjects.

Séna, Baron von. Known as connected for many years with the observatory at Athens, which was founded by his father. Died at Vienna, April 15th, in the sixty-fifth year of his age.

Simon, Dr. Professor of Surgery in the University of Heidelberg for fifty-three years. Died recently in that city.

Simskowski, George F. Best known from his report of travels of the Russian mission through Mongolia to China. Died in the spring of 1875, at the age of eighty-five.

Smith, George. Connected with the British Museum. Distinguished in the department of Assyrian antiquities and history. Died at Aleppo on the 19th of August.

Snell, Professor Ebenezer S. Professor of Mathematics in Amherst College, Massachusetts. Died September 18th, at the age of seventy-five.

Transon, Abel. An eminent mathematician and professor in the Polytechnic School at Paris. Died in that city in August, at the age of seventy.

Van Houtte, Louis. An eminent Belgian horticulturist, distinguished for his scientific knowledge of plants and his numerous experiments in regard to their growth. Died May 9th, at the age of sixty-six.

Vignoles, Charles B. A well-known English railway engineer. Died in November, at the age of eighty-two.

Von Baer. An eminent Russian naturalist.

Von Heuglin, Theodor. A distinguished African explorer and collector; a specialist in ornithology. Died at Stuttgart, at the age of fifty-two.

Von Waltershausen, Dr. Professor of Mineralogy at Göttingen, where he died, October 16th, aged sixty-seven. Specially interested in researches upon volcanoes.

Von Willemoes-Suhm, Dr. R. Born September 11th, 1847. One of the zoologists of the *Challenger* expedition. Died on board that vessel between the Sandwich Islands and Tahiti, September 13th, at the age of thirty.

Wing, Rev. Augustus. Especially interested in the investigation of the rocks of Vermont, particularly the crystalline limestone, quartzite, and slates of the central portion of the state; discoverer of Lower Silurian fossils in the crystalline limestone. Died at Rochester, Vermont, January 19th, at the age of sixty-seven.

Wright, Dr. Thomas S. A practicing physician, who found time for investigations in British marine zoology. Died in Edinburgh, in October, aged fifty-eight.

Wyndham, T. Heathcote G. A chemical mineralogist. Died in November.

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SELECT WORKS ON SCIENCE PUBLISHED DURING 1876.

The following list of books relating to the several departments of science contains only a small portion of those published during the past year, but, it is believed, embraces the most important. The limitations of the *Record* preclude an exhaustive bibliographical enumeration or plan; nor, indeed, is this required by readers. Works only have been introduced that have features of general interest to commend them, especially such as have been more or less favorably noticed in the principal journals devoted to general science, and mention will be found of the places in the several journals where criticisms are contained. These references will serve in lieu of the critical notices which were proposed in a previous volume for the present *Record;* experience having shown that, in order to do justice to the several works and to ourselves, more space would be required than could be well spared for the purpose.

Whenever the volumes themselves were accessible, the titles and collations have been taken directly from them. In many cases, however, the compiler has been obliged to depend solely on the titles contained in the journals in which the volumes have been noticed, or upon booksellers' announcements. These are often, and indeed generally, deficient in some point or other: *e.g.*, the title may be imperfect or altered; the date of publication may be omitted, and then it can not be certain whether the volume has been published during the current year or in a past one; there is a difference in the statements as to sizes; the collation is frequently absent or erroneous, and the number of pages incorrectly given, and sometimes even the place of publication is omitted. Wherever the means of verification or correction by referring to the volumes themselves have been possible, they have been improved; unfortunately, however, in most cases the volumes themselves could not be consulted; the purchases for the public libraries of Washington are generally very [illegible] history, and works may have been published

for many months, and even years, before they are procured. The compiler therefore is obliged to ask the indulgence of readers for any shortcomings in the enumerations of the volumes recorded.

All the scientific works sent to the editor of the *Record* have been, and will hereafter be enumerated, whether specially noticed in the journals in question or not. The responses to the invitation for the transmission of copies to the editor for notice have been numerous, but many important publications have been withheld. In the interest of accuracy and completeness of enumeration, the editor renews his request for copies of new works for notice in future numbers of the *Record's* Bibliography.

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[The Academy, Sept. 23, pp. 308, 309.]

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Kittredge (A. O.). The Compendium of Architectural Sheet-Metal Work. Profusely Illustrated. Embracing Rules and Directions for Estimates, Items of Cost, Nomenclature, Tables of Brackets, Modillions, Dentals, Trusses, Stop-Blocks, Frieze-Pieces, etc., Architect's Specifications, Tables of Tin-Roofing, Galvanized Iron, etc., etc. To which is added the Exemplar of Architectural Sheet-Metal Work, containing Details of the Centennial Buildings and other Important Sheet-Metal Work, Designs and Prices of Architectural Ornaments as Manufactured for the Trade by the Kittredge Cornice and Ornament Co., and a Catalogue of Cornices, Window-Caps, Mouldings, etc., as manufactured by the Kittredge Cornice and Ornament Co. Philadelphia: H. C. Baird & Co. 1876. (8vo, 565 pp. Price, $10 00.)

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[Popular (The) Science Monthly, X., 375.]

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Q. INDEX TO THE REFERENCES.

In the large number of serial works received regularly for use in the preparation of material for the *Record*, it has been found expedient to adopt some mode of abbreviating the titles, so as to save both time and space in writing and printing them. For this purpose the different countries have been represented by letters, and the journals numbered as in the following table. Publications referred to only occasionally are indicated by abbreviations of their titles at the ends of the articles. Where no references are made, it is to be understood that the article is partially or entirely original, and prepared by the editor or his collaborators; in some cases, however, that the quotation has been mislaid or overlooked.

The list of works here mentioned relates simply to those most frequently consulted—especially those coming direct through the post-office—and forms but a small portion of those passed regularly in review. The unrivaled scientific library of the Smithsonian Institution is in regular and constant receipt of the latest publications from at least one thousand societies and establishments, public and private, in different parts of the world, all of which are used to a greater or less extent by the editor and his associates in the preparation of the *Annual Record*.

A. *Great Britain*.

1. The Chemical News and Journal of Physical Science. Weekly. London.
2. Land and Water. Hunting, Shooting, Fishing, practical Natural History. Weekly. London.
3. Iron: the Journal of Science, Metals, and Manufactures: with which is incorporated the Mechanics' Magazine, established 1823. Weekly. London.
4. Hardwicke's Science Gossip. Monthly. London.
5. The Popular Science Review. Quarterly. London.
6. The Geographical Magazine. Monthly. London.
7. London, Edinburgh, and Dublin Philosophical Magazine. Monthly. London.
8. Scientific Review: Record of Progress in Arts, Industry, and Manufactures; and Journal of the Inventors' Institute. Monthly. London.

10. The Annals and Magazine of Natural History. Monthly. London.

11. Proceedings of the Scientific Meetings of the Zoological Society of London. London.

12. Nature: a weekly illustrated Journal of Science. London.

13. The Academy: a weekly review of Literature, Science, and Art. London.

14. The Pharmaceutical Journal and Transactions of the Pharmaceutical Society. Weekly. London.

15. The Athenæum: Journal of English and Foreign Literature, Science, and Fine Arts, Music, and the Drama. Weekly. London.

16. The Quarterly Journal of Science, and Annals of Mining, Metallurgy, Engineering, Industrial Arts, Manufactures, and Technology. London.

17. The Journal of Applied Science: a monthly record of progress in the Industrial Arts. London.

18. English Mechanic and World of Science. With which are incorporated "The Mechanic," "Scientific Opinion," and the "British and Foreign Mechanic." Weekly. London.

19. The Field, the Farm, the Garden: the Country Gentleman's Newspaper. Weekly. London.

20. Medical Times and Gazette. Weekly. London.

21. Journal of the Chemical Society, containing the papers read before the Society, and abstracts of chemical papers published in other journals. Monthly. London.

22. Illustrated London News. Weekly. London.

23. Journal of the Society of Arts. Weekly. London.

24. The Telegraphic Journal, and Electrical Review. Weekly. London.

25. The Electrical News and Telegraphic Reporter. Weekly. London.

26. Monthly Notices Royal Astronomical Society of London.

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28. Proceedings of the Royal Society of London.

B. *France.*

1. Bulletin hebdomadaire de l'Association Scientifique de France. Weekly. Paris.

3. Les Mondes: Revue hebdomadaire des Sciences et de leurs Applications aux Arts et à l'Industrie. Weekly. Paris.

4. Le Moniteur Scientifique du Dr. Quesneville. Journal des Sciences pures et appliquées. Bi-monthly. Paris.

5. Le Technologiste, ou Archives des Progrès de l'Industrie française et étrangère. Monthly. Paris.

6. Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences. Weekly. Paris.

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10. Bulletin Mensuel de la Société d'Acclimatation. Monthly. Paris.

11. Revue de Thérapeutique Medico-chirurgicale. Bi-monthly. Paris.

12. Bulletin général de Thérapeutique médicale et chirurgicale. Bi-monthly. Paris.

13. La Nature. Weekly. Paris.

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18. Annales des Sciences geologiques. Hébert and Alphonse Milne-Edwards. Occasional. Paris.

19. La Chasse Illustrée. A. Didot. Weekly. Paris.

20. Materiaux pour l'Histoire primitive et naturelle de l'Homme. Monthly. Toulouse.

21. Revue d'Anthropologie de M. Paul Broca. Quarterly. Paris.

22. Bulletin Internationale de l'Observatoire de Paris.

C. *Germany and Austria.*

1. Aus der Natur. Die neuesten Entdeckungen auf dem Gebiete der Naturwissenschaften. Weekly. Leipsic.

2. Archiv der Pharmacie. Monthly. Halle.

3. Das Ausland. Ueberschau der neuesten Forschungen auf dem Gebiete der Natur- Erd- und Völkerkunde. Weekly. Augsburg.

4. Badische Gewerbezeitung für Haus und Familie. Monthly. Karlsruhe.

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8. Industrie-Blätter: Wochenschrift für Fortschritt und Aufklärung in Gewerbe, Hauswirthschaft, Gesundheitspflege, etc. Weekly. Berlin.

9. Kurze Berichte über die neuesten Erfindungen, Entdeckungen und Verbesserungen im Gebiete des Gewerbewesens, des Handels und der Landwirthschaft. Monthly. Mannheim.

10. Landwirthschaft und Industrie; Monatsschrift für Landwirthe, Fabrikanten und Geschäftsleute jeder Art. Monthly. Berlin.

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12. Oberlausitzer Gewerbeblatt. Organ der Gewerbe- und Handwerker-Vereine des Königreichs Sachsen. Semi-monthly. Bautzen.

13. Polytechnisches Central-Blatt. Semi-monthly. Leipsic.

14. Polytechnisches Journal, etc. Dr. E. M. Dingler. Semi-monthly. Augsburg.

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16. Blätter für Gewerbe, Technik, und Industrie. Leipsic.

17. Mittheilungen aus Justus Perthes' geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie. Dr. A. Petermann. Monthly. Gotha.

18. Chemisches Central-Blatt. Repertorium für reine, pharmaceutische, physiologische, und technische Chemie. Weekly. Leipsic.

19. Der Naturforscher. Wochenblatt zur Verbreitung der Fortschritte in den Naturwissenschaften. Weekly. Berlin.

21. Neues Jahrbuch für Pharmacie. Monthly. Heidelberg.

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23. Das Deutsche Wollen-Gewerbe. Organ für die Wollen waaren-Industrie, etc. Weekly. Grüneberg.

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25. Muster-Zeitung. Zeitschrift für Färberei, Druckerei, Bleicherei, Appretur, etc. Dr. F. Springmühl. Weekly. Berlin.

26. Deutsche Färber-Zeitung. J. C. H. Geyer. Bi-monthly. Mühlhausen.

27. Preussisches Handelsarchiv. Wochenschrift für Handel, Gewerbe und Verkehrs-Anstalten. Weekly. Berlin.

28. Central-Blatt für Agrikulturchemie und rationellen Wirthschaftsbetrieb. Monthly. Leipsic.

29. Bayerisches Industrie- und Gewerbeblatt. Monthly. Munich.

30. Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte. Monthly. Braunschweig.

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2. Proceedings of the Academy of Natural Sciences of Philadelphia. Monthly. Philadelphia.

3. Proceedings of the Boston Society of Natural History. Quarterly. Boston.

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ALPHABETICAL INDEX.

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N.

T.

THE END.

BOSWELL'S JOHNSON. The Life of Samuel Johnson, LL.D., including a Journal of a Tour to the Hebrides. By JAMES BOSWELL, Esq. Edited by JOHN WILSON CROKER, LL.D., F.R.S. With a Portrait of Boswell. 2 vols., 8vo, Cloth, $4 00.

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